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SECTION 024121 – GENERAL SAFETY AND HISTORICAL SITE WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Safety at historical sites.
2. Historical Site Preservation.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1. The Generator and Automatic Transfer switch (ATS) are to remain the property of the Owner. Coordinate with Park management for relocation of old generator and ATS.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during operations remain the property of Owner.

PART 2 - SITE AREAS

2.1 SITE AREA REQUIREMENTS

- A. The Park management will provide an area for project staging. This area will be used for contractor's equipment and material storage, vehicle parking and trash. The Contractor shall provide all security measures necessary to assure the protection of equipment, materials in storage, completed work, and the project in general. Contractor is responsible for providing their own toilet facilities and removal of all trash from the construction site. The use of the Owner's trash receptacles is prohibited. The Contractor is to coordinate with Park management for appropriate staging areas and camping areas. The Contractor is responsible for providing fencing or barriers to prevent the public from having access to staging and storage areas.
- B. Typical work day is Monday – Friday, 8AM to 5PM. Work that is conducted outside of this time frame must be pre-approved by Park Management.
- C. On-site camping will only be allowed at the discretion of the Park management. Camping in fee areas is prohibited and no services will be provided.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Contractor is responsible for locating all utilities (both from the utility and owners infrastructure) and is responsible for repairing any utilities that are damaged during construction.
- B. Any costs for locating or repairing utilities shall be included in the Contractors bid.
- C. The Contractor is responsible for removing existing Fire Alarm wiring that is being replaced. Underground conduit or direct buried wire that is not exposed may be abandoned in place.

3.2 HISTORICAL SITE PRESERVATION AND SAFETY

- A. Original Condition: The Contractor shall keep historical sites in original conditions or return to original conditions when applicable at Owners approval. This includes but is not limited to the following:
 - 1. Historical building shall be kept in as is condition. Necessary construction in those buildings shall be done in a neat and workman like manner. Debris tracked in shall be cleaned each day to the condition the building was found in and to the satisfaction of the Park management.
 - 2. It is expected that work in these buildings will be done with the utmost care. In the event that damage is encountered it shall be reported immediately to the Park management to determine the method and means of repairs. All costs of contractor caused damage shall be borne by the Contractor. Careless construction will not be tolerated, and will be subject to a Stop Work order and evaluation of personnel and methods involved.
 - 3. Boardwalks may be carefully deconstructed for trench crossings. The Contractor is responsible for restoring boardwalks to before construction standards. Contractor shall coordinate this work with the Park management before beginning. Park management recommends removing limited number of boards and trenching around stringers. Pictures shall be taken before and after to document repair for use by the Park management if they request.
 - 4. Any equipment that is added and affects the aesthetic of the buildings must have Owner approved enclosures.
 - 5. Contractor is responsible for any damages to historical buildings, sidewalks, fences or any other items of archeological significance.
 - 6. Any ground that has trenching shall be returned to original surface condition. Contractor is responsible for any seeding. Seeding mix will be specified by Owner. Recommended seed to be 'Native Valley Mix'. Seed mixture must be approved by Park management.
 - 7. Contractor is responsible for bracing building rafters/walls to enable access and movement in buildings where building integrity is of concern. Contractor is responsible to bring any integrity issues of buildings to the Owner and Engineer.
 - 8. Contractor is responsible for taking before and after pictures of all areas and buildings where work is done. The Contractor must provide the Owner with a digital copy of both before and after pictures when the job is completed.

- B. Trenching: For historical sites, minimal disruption is a high priority. All trenches have been designed to be a maximum of either 24" or 12" in width. These dimensions were used during archeological surveying.
 - 1. The Contractor must obtain prior approval for any trench that is greater in dimension than what is called out in the drawings.
- C. Uncovered Artifacts: For historical sites, there is a likely probability that artifacts will be uncovered during trenching or excavation.
 - 1. If an artifact is uncovered, the Contractor is responsible to immediately notify the Park management or onsite archaeologist.
 - 2. In the case of an uncovered artifact, the Contractor is expected to move ahead to another work area after notifying the proper personnel. Onsite archaeologist will need approximately 2-4 hours to carefully excavate the artifact.
 - 3. It is at the archaeologist or Owners discretion on when work can resume in the area of where the artifact was uncovered.
- D. Temporary Protection: Provide temporary barricades, signs and other protection required to prevent injury to people and damage to adjacent buildings and facilities.
 - 1. The Park will remain open to the public during construction. Park management must be notified and updated on a routine basis as to scheduled closing and reopening of work areas. To the extent practical, Work shall be scheduled to minimize impact to the public.
 - 2. Provide protection to ensure safe passage of people around selective work area and to and from occupied portions of building.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective operations.
 - 4. All trenching shall have appropriate orange fence barriers. All trenching work shall be approved by the Park management in advance to reduce conflict between the work of trenching and ground work with the operation of the historical site. Open trench lengths shall be kept to a practical minimum. Measures shall be taken to prevent public access to work area.
- E. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of the building that is being worked on.
 - 1. The design for work in the buildings is, for the most practical degree, for an installation that would be possible with the least amount of hazard to the worker and the least likelihood of damage to the building. Historic buildings are fragile and contractors care is imperative.
- F. Remove temporary barricades and protections where hazards no longer exist.
- G. Importance of Safety: The Contractor and all Subcontractors (at any tier or level) recognize that safety is paramount at all times.

1. The Contractor shall perform the work in a safe manner with the highest regard for safety of its employees and all other individuals and property at the work site. Contractor shall maintain its tools, equipment, and vehicles in a safe operating condition and take all other actions necessary to provide a safe working environment for performance of work required under this Contract.
2. The Contractor is solely responsible for the means, methods, techniques, sequences and procedures for coordinating and constructing the Work, including all site safety, safety precautions, safety programs, and safety compliance with OSHA and all other governing bodies.

H. Particular Safeguards:

1. The Contractor shall erect and maintain safeguards for safety and protection, including posting danger signs and other warnings against hazards, installing suitable barriers and lighting, promulgating safety regulations, and providing notification to all parties who may be impacted by the Contractor's operations.
 2. The Contractor shall not encumber or load or permit any part of the construction site to be encumbered or loaded so as to endanger the safety of any person(s).
- I. Compliance with Safety Laws: Contractor represents and warrants to Owner that it knows and understands all federal, state and local safety statutes, rules, and regulations (Laws) related to the work under this Contract. Contractor shall comply with these Laws. Contractor shall keep all material data safety sheets on site and available at all times.
- J. Remedy property damage: The Contractor shall promptly remedy damage and loss to property caused in whole or in part by the Contractor, a Subcontractor of any tier or level, or anyone employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible.
- K. Designation of Safety Representative: Unless the Contractor designates, in writing to the Owner and the Engineer, another responsible member of the Contractor's organization as the Safety Representative, the Contractor's superintendent is the Safety Representative. The Safety Representative is defined as that member of the Contractor's organization responsible for all safety under this Contract.
- L. Release/Indemnity of Owner and Architect/Engineer: The Contractor agrees that the Owner and Engineer are not responsible for safety at the work site and releases them from all obligations and liability regarding safety at the work site. The Contractor shall indemnify and defend the Owner and the Engineer against and from all claims, liabilities, fines, penalties, orders, causes of action, judgments, losses, costs and expenses (including but not limited to court costs and reasonable attorney fees), arising from injuries and death to any persons and damage to real and personal property arising from, in connection with, or incidental to Contractor's safety responsibilities under this Contract.

3.3 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective operations. Return adjacent areas to condition existing before selective operations began.

- B. The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract during performance of the Work and at the direction of the Owner or Engineer. At completion of the Work, the Contractor shall remove from and about the Project waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials.
- C. If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the cost thereof shall be charged to the Contractor.

END OF SECTION 024121

SECTION 024121 – ELECTRIC POWER SYSTEM SPECIFICATION; 40kW GENERATOR SYSTEM

PART 1 - GENERAL

1.1. DESCRIPTION OF SYSTEM

1.1.1. Provide a standby power system to supply electrical power in event of failure of normal supply, consisting of a propane vapor fueled, liquid cooled engine, an AC alternator and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.

1.1.2. Provide an automatic transfer switch that will initiate a signal on primary power failure and automatically detect a secondary power source, transferring the load to this secondary source. On restoration of primary power, the switch must automatically retransfer the load back to primary power and signal the secondary source to shut down. The switch must be a self contained device with all features described herein.

1.2. REQUIREMENTS OF REGULATORY AGENCIES

1.2.1. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.

1.2.2. The generator set must conform to applicable NFPA standards.

1.2.3. The generator set must be available with the Underwriters Laboratories listing (UL2200) for a stationary engine generator assembly.

1.2.4. The transfer switch must be UL listed for use in emergency systems.

1.2.5. The generator set must meet current EPA federal emission guidelines for stationary standby power generation.

1.3. MANUFACTURER QUALIFICATIONS

1.3.1. This system shall be Generac Power Systems® supplied by TW Enterprises, Inc. or an approved equal who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of twenty years, thereby identifying one source of supply and responsibility.

1.3.2. To be classified as a manufacturer, the builder of the generator set must manufacture, at minimum, engines or alternators.

1.3.3. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

PART 2 - ENGINE-GENERATOR SET

ELECTRICAL GENERATOR

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2.1.1. The prime mover shall be a liquid cooled, liquid propane fueled, naturally aspirated engine of 4-cycle design. It will have 8 cylinders with a minimum displacement of 5.4 liters, with a minimum rating of 62 BHP. The unit requires a minimum rated output of 40 kW at an operating speed of 1800 RPM, at jobsite elevation and conditions.

2.1.2. The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system providing visual diagnostic means to determine if the system is operating with a normal engine coolant level. The radiator shall be designed for operation in 122 degrees f, 50 degrees c ambient temperature.

2.1.3. The intake air filter with replaceable element must be mounted on the unit. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter with internal bypass and replaceable element. Engine coolant and oil drain extensions, equipped with pipe plugs, must be provided to outside of the mounting base for cleaner and more convenient engine servicing. A fan guard must be installed for personnel safety.

2.1.4. The engine shall have a battery charging DC alternator with a transistorized voltage regulator. Remote 2-wire starting shall be by a solenoid shift, electric starter.

2.1.5. The engine fuel system shall be designed for primary operation on propane having a BTU content of 1000 BTU per cubic foot delivered to the unit in a vapor state. A carburetor, secondary regulator, fuel lock-off solenoid and all piping must be installed at the point of manufacturing, terminating at a single pipe opening external to the mounting base.

2.1.6. The engine shall have a unit mounted, thermostatically controlled water jacket heater to aid in quick starting. The wattage shall be as recommended by the manufacturer. The contractor shall provide proper branch circuit from normal utility power source.

2.1.7. Sensing elements to be located on the engine for low oil pressure shutdown, high coolant temperature shutdown, low coolant level shutdown, over-speed shutdown and over-crank shutdown. These sensors are to be connected to the control panel using a wiring harness with the following features: wire number labeling on each end of the wire run for easy identification, each sensor connection shall be sealed to prevent corrosion and all wiring to be run in flexible conduit for protection from the environment and any moving objects.

2.1.8. Provide the following items installed at the factory:

2.1.8.1. Model 2000 sound attenuated Level 2 weather protective enclosure: The engine-generator set shall be factory enclosed in a 14 gauge steel enclosure constructed with corner posts, uprights and headers. The roof shall be made of aluminum, aid in the runoff of water and include a drip edge. The enclosure shall be coated with electro-statically applied powder-coated paint, Rhino coat, baked and finished to manufacturer's specifications. The color will be industrial gray-standard. The enclosure shall be completely lined with 1" thick, UL 94 HF-1 listed, sound deadening material. This material must be of a self extinguishing design. The enclosure is to have large, hinged, removable doors to allow access to the engine, alternator and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or JS5000. The use of pop-rivets weakens the paint system and shall not be allowed on external painted surfaces. Each door will have lockable hardware with identical keys. Padlocks do not meet this specification. The enclosure shall include an air discharge hood that protects the radiator core and directs the hot discharge air upward preventing re-circulating hot air.

2.1.8.2 The exhaust silencer shall be provided of the size as recommended by the manufacturer and shall be of critical grade. The silencer shall be mounted within the sound attenuated weather protective enclosure for reduced exhaust noise and provide a clean, smooth exterior design. It shall be connected to the engine with a flexible, seamless, stainless steel exhaust connection. A rain cap will terminate the exhaust pipe. All components must be properly sized to assure operation without excessive back pressure when installed.

2.1.8.3. Provide an automatic dual rate battery charger. The automatic equalizer system shall monitor and limit the charge current to 10amps. The output voltage is to be determined by the charge current rate. The charger must be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

2.1.9. Engine speed shall be controlled by isochronous governor with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.

2.1.10. One step load acceptance shall be 100% of engine-generator set nameplate rating and meet the requirements of NFPA 110 paragraph 7.13.7

2.1.11. The generator system shall support generator start-up and load transfer within 10 seconds.

2.2. ALTERNATOR

2.2.1. The alternator shall be a 4 pole revolving field type, 4 lead, wired for 120/240 VAC, 1 phase, 60 Hz, upsized to 60 kW with a brushless PMG exciter and be capable of 62 inrush kva at 20% voltage dip. Photosensitive components will not be permitted in the rotating exciter. The stator shall be direct connected to the engine to ensure permanent alignment. The generator shall meet temperature rise standards for Class "H" insulation; operate within Class "F" standards for extended life. All leads must be extended into an AC connection panel. The alternator shall be protected by internal thermal overload protection and an automatic reset field circuit breaker.

2.2.2. One-step load acceptance shall be 100% of engine-generator set nameplate rating and meet the requirements of NFPA 110 paragraph 5-13.2.6. The generator set and regulator must sustain at least 300% short circuit current for 10 seconds during 1 phase fault.

2.2.3. A NEMA 1 panel that is an integral part of the generator set must be provided to allow the installer a convenient location in which to make electrical output connections. A fully rated, isolated neutral must be included by the generator set manufacturer to insure proper sizing.

2.2.4. The electric plant (engine and alternator) shall be mounted with internal vibration isolation onto a welded steel base. External vibration isolation shall not be required for normal pad mounted applications.

2.2.5. Provide the following items installed at the factory:

2.2.5.1. A thermal magnetic main line circuit breaker carrying the UL mark shall be factory installed. The breaker shall be rated per generator output amps within UL 2200 parameters. The line side connections are to be made at the factory. Output lugs shall be provided for load side connections. Shunt trip and auxiliary contacts for breaker position shall be included. A system utilizing manual reset field circuit breakers and current transformers is unacceptable.

2.3. CONTROLS

2.3.1. The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators capable of meeting all requirements of NFPA 110.

2.3.2. The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic management system if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.

2.3.3. Communications shall be supported with building automation via the Modbus protocol without network cards or protocol exchangers. Optional internet and intranet connectivity shall be available.

2.3.4. The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.

2.3.5. Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.

2.3.6. A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.

2.3.7. Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .1msec data logging capabilities.

2.3.8. The control system shall provide pre-wired customer use I/O: 4 contact inputs, 2 analog inputs, 4 relay outputs, and communications support via RS232, RS485, and an optional modem. Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.

2.3.9. The control panel will display all user pertinent unit parameters including:

- Engine and alternator operating conditions
- Oil pressure and optional oil temperature
- Coolant temperature and level alarm
- Fuel level (where applicable)
- Engine speed
- DC battery voltage
- Run time hours
- Generator voltages, amps, frequency, kilowatts, and power factor
- Alarm Status

Current alarm(s) condition per NFPA 110 level 1

Alarm Log of last twenty alarm events (date and time stamped)

2.3.10. For system reliability and security concerns, access to and manipulation of the internal operating parameters and alarm limits shall be conducted via password protected PC based software by trained personnel. System configuration support shall be provided locally or remotely by the manufacturers servicing representatives.

PART 3 - AUTOMATIC TRANSFER SWITCH

3.1. GENERAL

3.1.1. The automatic transfer switch shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard 1008 with fuse or circuit breaker protection. Representative production samples of the transfer switch supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 312.6. The manufacturer shall furnish schematic and wiring diagrams for the particular automatic transfer switch and a typical wiring diagram for the entire system.

3.2. RATINGS & PERFORMANCE

3.2.1. The automatic transfer switch shall be a 2 pole design rated for 200 amps continuous operation in ambient temperatures of -20 degrees Fahrenheit (-30 degrees Celsius) to +140 degrees Fahrenheit (+60 degrees Celsius). Main power switch contacts shall be rated for 600 V AC minimum. The transfer switch supplied shall have a minimum withstand and closing rating when fuse protected of 200,000 amperes. Where the line side over-current protection is provided by circuit breakers, the short circuit withstand and closing ratings shall be 35,000 amperes RMS. These RMS symmetrical fault current ratings shall be the rating listed in the UL listing or component recognition procedures for the transfer switch. All withstand tests shall be performed with the over-current protective devices located external to the transfer switch.

3.3. CONSTRUCTION

3.3.1. The transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. When switching the neutral, this action prevents the objectionable ground currents and nuisance ground fault tripping that can result from overlapping designs. The transfer switch shall be approved for manual operation. The electrical operating means shall be by electric solenoid. Every portion of the contactor is to be positively mechanically connected. No clutch or friction drive mechanism is allowed, and parts are to be kept to a minimum. This transfer switch shall not contain integral over-current devices in the main power circuit, including molded case circuit breakers or fuses.

3.3.2. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching. Maximum electrical transfer time in either direction shall be 160 milliseconds, exclusive of time delays. Main switch contacts shall be high pressure silver alloy with arc chutes to resist burning and pitting for long life operation.

3.4. CONTROLS

3.4.1. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.

3.4.2. A solid state under-voltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific application needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down system voltage of 120/240 vac 1 phase to 24VAC, helping to protect the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.

3.4.3. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start, adjustable, .1 to 10 seconds, shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.

3.4.4. Transfer the load to the engine-generator set after it reached proper voltage, adjustable from 70-90% of system voltage, and frequency, adjustable from 80-90% of system frequency. A solid state time delay, adjustable from 5 seconds to 3 minutes, shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.

3.4.5. Retransfer the load to the line after normal power restoration. A return to utility timer, adjustable from 1-30 minutes, shall delay this transfer to avoid short term normal power restoration.

3.4.6. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.

3.4.7. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cool-down timer, adjustable from 1-30 minutes, shall permit the engine to run unloaded to cool-down before shutdown. Should the utility power fail during this time, the switch will immediately transfer back to the generator.

3.4.8. Provide an engine minimum run timer, adjustable from 5-30 minutes, to ensure an adequate engine run period.

3.4.9. The transfer switch shall have a time delay neutral feature to provide a time delay, adjustable from .1-10 seconds, during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass all transition features when immediate transfer is required.

3.4.10. The transfer switch shall have an in-phase monitor which allows the switch to transfer between live sources if their voltage waveforms become synchronous within 20 electrical degrees within 10 seconds of transfer initiation signal. A switch must be provided to bypass this feature if not required.

3.4.11. If the in-phase monitor will not allow such a transfer, the control must default to time delay

neutral operation. Switches with in-phase monitors which do not default to time delay neutral operation are not acceptable.

3.4.12. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.

3.4.13. Provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.

3.4.14. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.

3.4.15. Provide a maintenance disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.

3.4.16. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, standby ready, transfer to standby, in-phase monitor, time delay neutral, return to utility, engine cool-down and engine minimum run. A "signal before transfer" lamp shall be supplied to operate from optional circuitry.

3.5. MISCELLANEOUS TRANSFER SWITCH EQUIPMENT

3.5.1. The transfer switch mechanism and controls are to be mounted in a NEMA 1 enclosure.

PART 4 - ADDITIONAL PROJECT REQUIREMENTS

4.1. APPLIED STANDARDS

4.1.1. The generator set must be manufactured to the applicable specifications on file with Underwriters Laboratories and the UL 2200 mark must be affixed.

4.1.2. The transfer switch must be UL listed and carry the UL mark for use in emergency systems.

4.2. FACTORY TESTING

4.2.1. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:

4.2.1.1. Verify all safety shutdowns are functioning properly.

4.2.1.2. Verify single step load pick-up per NFPA 110-1996, Paragraph 5-13.2.6.

4.2.1.3. Verify transient and voltage dip responses and steady state voltage and speed (frequency) checks.

4.2.2. Before shipment of the transfer switch shall be tested under operating conditions for performance and proper functioning of control and interfacing circuits. Tests shall include:

4.2.2.1. Verify all timing sequences operate properly and are set to factory settings.

4.2.2.2. Verify the transfer mechanism operates properly.

4.2.2.3. Verify all manual operations and indicators are functioning properly.

4.3. OWNER'S MANUALS

4.3.1. Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

4.4. INSTALLATION

4.4.1. Contractor shall install the complete electrical generating system including all fuel connections in accordance with the manufacturer's recommendations as reviewed by the Engineer.

4.5. SERVICE

4.5.1. Supplier of the electric plant and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

4.6. WARRANTY

4.6.1. The standby electric generating system components, complete engine-generator and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of 60 months. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge. Travel and labor shall be included. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

4.7. STARTUP AND CHECKOUT

4.7.1. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:

4.7.1.1. Ensuring the engine starts (both hot and cold) within the specified time.

4.7.1.2. Verification of engine parameters within specification.

4.7.1.3. Verify no load frequency and voltage, adjusting if required.

4.7.1.4. Test all automatic shutdowns of the engine-generator.

4.7.1.5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using a portable load bank. This test shall include 1 hour 50% load, 1 hour 75% load and 2 hours 100% load.

4.8. SUBMITTALS

4.8.1. Provide six complete sets of Engineering Submittal for approval, prior to production release, showing all components, in addition to the engine and generator. Submittals shall include compliance with these specifications.

4.9. SUBSTITUTIONS

4.9.1. The emergency power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel and exhaust components have all been sized and designed around this equipment. Should any substitutions be made, the contractor shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs which may result from such substitutions. Alternate equipment suppliers shall furnish equipment submittals 10 days prior to bid date for approval to bid. As part of the submittals, the substitute manufacturer shall supply as a minimum engine, alternator and control panel wiring diagrams and schematics.

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Copper conductors throughout.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire. Type MC Cable allowed in size 10 and smaller only. MC shall not be used as home runs to panelboards.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Coordinate with the serving utility.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- I. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- I. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- J. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- D. Cut sleeves to length for mounting flush with both wall surfaces.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized.
 - 2. Perform each visual and mechanical inspection and electrical test using a Megger for conductors 2/0 and larger.

- C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
 4. Provide a test report with the project closeout documents.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Multimode optical-fiber cabling.
 - 2. UTP cabling.
 - 3. RS-485 cabling.
 - 4. Low-voltage control cabling.
 - 5. Control-circuit conductors.
 - 6. Identification products.

1.2 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- B. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.
- C. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Involved in cable testing for a minimum of five years.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspect cables upon receipt at Project site.
- B. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
 2. Peak Optical Smoke Density: 0.5 or less.
 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 PATHWAYS

- A. Support of Open Cabling: NRTL labeled for support of **Category 6** cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
 2. Lacing bars, spools, J-hooks, and D-rings.
 3. Straps and other devices.
- B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high, and 2-1/8 inches deep.
- C. Provide plenum cable for any space listed as a plenum and thus requiring plenum cable.

2.3 BACKBOARDS

- A. Description: AC Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with white latex paint. Comply with requirements in Division 09 Section "Interior Painting."

2.4 OPTICAL-FIBER CABLE

- A. Specified in section 284 631.

UTP CABLE

- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Belden CDT Inc.; Electronics Division.
 2. Berk-Tek; a Nexans company.
 3. CommScope, Inc.
 4. Draka USA.
 5. Genesis Cable Products; Honeywell International, Inc.
 6. KRONE Incorporated.
 7. Mohawk; a division of Belden CDT.
 8. Nordex/CDT; a subsidiary of Cable Design Technologies.
 9. Superior Essex Inc.
 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
 11. 3M.
 12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

- C. Description: 100-ohm, four-pair UTP.
1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 6.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or Type CMG.
 - b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR; complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX.
 - e. Multipurpose: Type MP or Type MPG.
 - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.5 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Technology Systems Industries, Inc.
 2. Dynacom Corporation.
 3. Hubbell Premise Wiring.
 4. KRONE Incorporated.
 5. Leviton Voice & Data Division.
 6. Molex Premise Networks; a division of Molex, Inc.
 7. Nordex/CDT; a subsidiary of Cable Design Technologies.
 8. Panduit Corp.
 9. Siemon Co. (The).
 10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.
- D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
- E. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.
- F. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.
- G. Workstation Outlets: Two port-connector assemblies mounted in single faceplate.
- H. Faceplates:
1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 2. Metal Faceplate: Stainless steel complying with requirements in Section 262726 "Wiring Devices."

3. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.
 - a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

I. Legend:

1. Machine printed, in the field, using adhesive-tape label, black on clear.

J.

2.6 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.7 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.8 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, power-limited cable, concealed in building finishes, complying with UL 83.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.
- D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 1. Smoke control signaling and control circuits.

2.9 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements.

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

- C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
1. Outlet boxes shall be no smaller than 4 inches square by 2-1/8 inches deep.
 2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by **2-1/8 inches** deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 3. Flexible metal conduit shall not be used.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Pathway Installation in Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
 2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard if entering room from overhead.
 4. Extend conduits 3 inches above finished floor.
 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1 and NFPA 70.
- B. General Requirements for Cabling:
1. Comply with TIA-568-C Series of standards.
 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
 3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
 4. Cables may not be spliced.
 5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
 10. Support: Do not allow cables to lie on removable ceiling tiles.
 11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

- C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Optical-Fiber Cable Installation:

1. Comply with TIA-568-C.3.
2. Terminate cable on connecting hardware that is rack or cabinet mounted.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.4 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 - 1. Class 1 remote-control and signal circuits, No 14 AWG.
 - 2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
 - 3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 18 AWG.

3.5 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical-Fiber Cable Tests:

- a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- b. Link End-to-End Attenuation Tests:
 - 1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for links shall be less than 2.0 dB.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Submit reports with project completion documents.

END OF SECTION 260523

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. See Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks and manholes, and underground handholes, boxes, and utility construction.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. ARC: Comply with ANSI C80.5 and UL 6A.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. PVC-Coated Steel Conduit: PVC-coated [**rigid steel conduit**] [**IMC**].
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch minimum.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT, FMC, and LFMC: Steel set-screw, steel compression type, or steel flex connectors.

- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Continuous HDPE: Comply with UL 651B.
- F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.
- I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb
 - 1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. Standard: Comply with SCTE 77.
 - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC."
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of hot-dip galvanized-steel diamond plate.
1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit, IMC.
 2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, EMT.
 3. Underground Conduit: RNC, SCH-40, 80-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: Rigid steel conduit, IMC.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Gymnasiums.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: Rigid steel conduit, IMC.
 7. Raceways for Optical Fiber or Communications Cable: EMT.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
- C. Minimum Raceway Size: 1/2 inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
 - 5.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from RNC to rigid steel conduit, or IMC before rising above the floor.
 - 4. PVC conduit shall not extend above grade.
 - 5. In exposed areas use rigid steel conduit or IMC to 8' above grade.
 - 6. Get approval from the structural engineer before conduit installation in concrete structural elements.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- O. Raceways for Optical Fiber and Communications Cable: Install as follows:
 - 1. 3/4-Inch Trade Size: Install raceways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
 3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- S. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Locate boxes so that cover or plate will not span different building finishes.
- X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface.
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- BB. Circuit identification: Provide circuit numbers on the inside of all boxes for all circuits contained therein. For boxes concealed above accessible ceilings or exposed in unfinished areas also provide circuit numbers marked on the box cover. Use permanent ink marker.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose,
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
6. Warning tape: Install printed Caution tape in the backfill above buried electrical 12" below grade.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG (UNO), stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 5/8 by 96 inches

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 4 AWG and smaller, and stranded conductors for No. 3 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No.6 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for taps to equipment grounding terminals.

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 - 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- I. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.
- J.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least 2 rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve in a manner that is acceptable to the serving utility.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install a bonding jumper to bond across flexible duct connections to achieve continuity.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
- B. Perform tests and inspections. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.

- b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
- 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 UNDERGROUND-LINE WARNING TAPE

- A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: **ELECTRIC LINE, HIGH VOLTAGE.**
3. Inscriptions for Orange-Colored Tapes: **TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.**

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Fasteners for Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
- F. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES".

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Auxiliary Electrical Systems Conductor and Cable Identification: Use marker tape to identify field-installed alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 2. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 3. Arc Flash Hazard. Provide all labeling on all equipment requiring arc flash hazard signage according to NEC Art. 110.16.
- C. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- D. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for emergency operations.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
 - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
 - d. Each equipment label shall include: the equipment designation as shown on the plans, the circuit source, voltage, phase, and amperage.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.

- b. Electrical switchgear and switchboards.
- c. Transformers.
- d. Motor-control centers.
- e. Disconnect switches.
- f. Enclosed circuit breakers.
- g. Motor starters.
- h. Push-button stations.
- i. Power transfer equipment.
- j. Contactors.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - 3. Colors for 120/240-V Circuits:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Neutral: White
- H. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

END OF SECTION 260553

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.
- D. Tamper resistant and weather proof devices.
1. Provide tamper resistant devices where required by the NEC.
 2. Provide weather proof devices for all devices installed outdoors or in damp or wet locations.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, feed through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Single Pole:
 - 2) Cooper; AH1221.
 - 3) Hubbell; HBL1221.
 - 4) Leviton; 1221-2.
 - 5) Pass & Seymour; CSB20AC1.
- 6) Two Pole:
 - 7) Cooper; AH1222.
 - 8) Hubbell; HBL1222.
 - 9) Leviton; 1222-2.
 - 10) Pass & Seymour; CSB20AC2.
- 11) Three Way and Four Way:
 - 12) Cooper; AH1223.
 - 13) Hubbell; HBL1223.
 - 14) Leviton; 1223-2.
 - 15) Pass & Seymour; CSB20AC3.
- 16) Cooper; AH1224.
- 17) Hubbell; HBL1224.
- 18) Leviton; 1224-2.
- 19) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.

- c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
- 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498. Provide 20A devices where required by code.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.
 - c. Leviton; 16252.
 - d. Pass & Seymour; 26252.
- B. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A. Provide 20A devices where required by code.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).

- c. Leviton; 56291-2 (single pole), 5623-2 (three way).
- d. Pass & Seymour; 2621 (single pole), 2623 (three way).

D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
- 2. Description: With neon-lighted handle, illuminated when switch is "off."

2.7 RESIDENTIAL DEVICES

A. Fan Speed Controls:

- 1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
- 2. Comply with UL 1917.
- 3. Three-speed adjustable slider 1.5 A.

B. Telephone Outlet:

- 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
- 2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e . Comply with UL 1863.

C. Combination TV and Telephone Outlet:

- 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 3562.
 - b. Leviton; 40159.
- 2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e . Comply with UL 1863.

D. Tamper resistant receptacles:

- 1. Provide tamper resistant devices where required by code whether specifically called out or not.

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters (in residential applications the suppression apparatus must be compatible with the AFCI device).
- B. Control: Continuously adjustable slider with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: **[Smooth, high-impact thermoplastic] [0.035-inch-thick, satin-finished, Type 302 stainless steel]**
 - 3. Material for Unfinished Spaces: **[Galvanized steel] [Smooth, high-impact thermoplastic].**
 - 4. Material for Damp Locations: **[Thermoplastic] [Cast aluminum]** with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, with lockable cover.

2.10 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Provide a neutral in all switch boxes.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, switchboards, and enclosed controllers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Fuses in all cases shall be acceptable for the available fault current.
- B. Service Entrance: Class L, time delay.
- C. Feeders: Class L, time delay.
- D. Motor Branch Circuits Class RK5, time delay.
- E. Other Branch Circuits: Class RK5, time delay.
- F. Control Circuits: Class CC, time delay.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstands" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified".

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, **240V** ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Double Throw, **240V** ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: [240] [600]-V ac, [30] [60] [100] A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: [240] [600]-V ac, [30] [60] [100] A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

- E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.4 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; with control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight ON pilot light.
 - 3. Isolated neutral lug.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 7. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Wash-Down Areas: NEMA 250, Type 4X.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform visual and mechanical and electrical inspection on each unit.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Multispeed.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Load-current , overload-relay heater list, or a list of settings of adjustable overload relays for each motor.

1.7 COORDINATION

- A. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Product Selection for Restricted Space: Drawings indicate maximum space allowed for enclosed controllers, allow for minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Substituted equipment shall comply with indicated maximum dimensions and clearances.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing/ Reversing, Two speed.
 3. Surface mounting.
 4. Pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing,/Two speed.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button.
 4. Surface mounting.
 5. Pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing/ Reversing/ Two speed.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button.
4. Surface mounting.
5. Pilot light.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
2. Configuration: Nonreversing/ Reversing.
3. Provide a minimum of a size 1, 3 pole motor starter.
4. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
5. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
6. Control Circuits: 120V ac, unless indicated otherwise after required coordination with the controls contractor.
7. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
8. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
9. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

10. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- c. Rockwell Automation, Inc.; Allen-Bradley brand.
- d. Siemens Energy & Automation, Inc.
- e. Square D; a brand of Schneider Electric.

2. Provide a factory mounted hand- off- auto selector switch on each combo starter.

3. Provide a minimum of a size 1, 3 pole motor starter.

4. Control Circuits: 120V ac, unless indicated otherwise after required coordination with the controls contractor.

5. Fusible Disconnecting Means:

- a. **NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.**
- b. **Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.**
- c. **Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.**

G. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

H. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- c. Rockwell Automation, Inc.; Allen-Bradley brand.
- d. Siemens Energy & Automation, Inc.
- e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing/ Reversing.

3. Contactor Coils: Pressure-encapsulated type.

- a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 5. Control Circuits: 120 V ac; unless indicated otherwise after required coordination with the controls contractor.
 6. Compelling relays shall ensure that motor will start only at low speed.
 7. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
 8. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
 9. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
 10. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 11. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 12. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 13. External overload reset push button.
- I. Combination Multispeed Magnetic Controller: Factory-assembled combination of multispeed magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.

2. Fusible Disconnecting Means:

- a. **NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.**
- b. **Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.**
- c. **Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.**

3. Nonfusible Disconnecting Means:

- a. **NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.**
- b. **Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.**
- c. **Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.**

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Wash-Down Areas: Type 4X.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

- A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 03 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch enclosed controller.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches and overload-relay pickup and trip ranges.
- B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. See Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.2 DEFINITIONS

- A. BAS: Building automation system.
- B. CE: Conformance Europeene (European Compliance).
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. OCPD: Overcurrent protective device.
- F. PID: Control action, proportional plus integral plus derivative.
- G. RFI: Radio-frequency interference.
- H. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Certificates: For each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

C. Product certificates.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cerus Industrial, Inc.
2. Danfoss Inc; Danfoss Drives Div.
3. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Business Unit.
4. Rockwell Automation, Inc; Allen-Bradley Brand.
5. Schneider Electric USA, Inc.
6. Siemens Energy & Automation, Inc.
7. Yaskawa Electric America, Inc.
8. ABB

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: Constant torque and variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
1. Units suitable for operation of NEMA MG 1 motors.
 2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 66 Hz, maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F. Note: see G. Enclosure for ambient temperatures less than 32 °F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Derating applied when above 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Enclosure: For temperatures below 32°F a heated enclosure will be required. Hoffman enclosure WF75LP recommended with A48P36 panel and DAH4002B heater.
- H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified".

2.4 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10-V dc, 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) ([0- to 10-V dc) which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

2.5 OPTIONAL FEATURES

- A. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4X.
 - 3. Wash-Down Areas: Type 4X.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.7 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Unguarded.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

- H. Cooling Fan and Exhaust System: For NEMA 250, Type 1 ; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120V ac; obtained from integral CPT.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
 - 2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- C. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch VFC.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Comply with NECA 1.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.

3.3 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. VFCs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager] before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 0275315 – WIRELESS PA SYSTEM

PART 1 - GENERAL

1.1 Section Included

A. Transmission System

1. Primary Control Center PC with Microphone, Optional secondary encoder.
2. Primary Internal or External Transmitter.

B. Wireless Notification and Mass Alert Devices.

1. Wirelessly Controlled Public Address Speaker.
2. Wirelessly Controlled Strobe Light.
3. Wirelessly Controlled Alphanumeric LED Message Board.
Wirelessly Controlled Siren.

1.2 References

1. This Technical Specification and Associated Drawings.
2. National Fire Protection Agency (NFPA) 72, National Electric Code 2010.
3. Visiplex, Inc. AlertWave Wireless Mass Notification System User Manuals.

1.3 System Description

A. Wireless Emergency Mass Notification system shall activate and wirelessly control remote alerting devices such as PA speakers, strobe lights, LED message boards and siren horns.

B. The main system shall include a dedicated microphone, full keyboard for data entry, serial connections to in-house alert system, serial connection to optional building automation systems, software and hardware interface for network access, FCC approved transmitter and a UPS power backup.

C. The main system shall be capable of sending alerts to the following devices:

1. Wirelessly Controlled PA Speakers: Activation of embedded tones and bells, pre-recorded voice alerts, user recorded voice alerts and Text to Speech voice alerts.
2. Wirelessly Controlled Strobe Lights: Activation of devices that have ON and OFF status, including strobe lights and sirens.
3. Wirelessly Controlled Alphanumeric LED Message Board: Activation of alphanumeric LED message boards that can display an alphanumeric message using different formats and effects. Alphanumeric LED message boards shall support alternate time display when LED message board is idle.
4. Wirelessly interface with local Fire Alarm system by providing dry-contact control and PA audio signal.
5. Wireless Pagers: Activation of alphanumeric, numeric, tone-only and voice pocket pagers.

6. Email and SMS Notification: Sending email messages to email subscribers and text messages to cellular phone subscribers (using Email to SMS processing supported by cellular provider).
7. Audio Output: Activation of voice alerts that may be played thorough the PC audio output and activation of voice alerts that may be played thorough the telephone line.
8. Network Notification: Sending alphanumeric alerts to Client software users.
9. Modem Dial Out: Sending alphanumeric alerts to pagers and cell phones that are capable of receiving messages using a 3rd party provider (TAP protocol via modem connection).

D. The system shall be capable of generating user attended alerts using the following interfaces:

1. Dialing in to the telephone line connected to the main system and following the system's prompts. Alerts shall be alphanumeric, activation commands or voice alerts.
2. Using PC software that allows network users to send audible, visual and alphanumeric messages from their PC.

E. The system shall be capable of generating automated alerts using the following interfaces:

1. Dry-contact closure of one of the alarms / dry-contacts modules.
2. Incoming serial data, which will be processed according to the active protocol on the specific serial port receiving the data.
3. Triggering a button or dry-contact closure of a wireless emergency call button or station (push buttons, pull cords, door and windows transmitters).
4. Receiving an email message that may be forwarded to a specific device or analyzed according to the Data Stream Analyzer protocol for conditional messaging.
5. Pre-programmed scheduled events that may activate individual or multiple wireless and non-wireless devices.

F. The main system shall provide a graphic Visual Control Panel for monitoring dry-contact alarm inputs, wireless emergency transmitters and stations and activation of alerts. The Visual Control Panel shall allow placement of visual indicators over a site map or any other image.

G. The main system shall archive all system activity with date and time for on-demand reports.

H. The main system shall be capable of accessing wireless devices and non-wireless devices individually and as a group, including groups of devices of different types. The main system shall support activation of wirelessly controlled PA speakers, strobe lights, alphanumeric LED message boards and siren horns individually or as a group. The messages may be initiated automatically or manually by the user.

I. The main system shall be capable of supporting 10000 devices, 1000 pre-recorded voice messages, 1000 dry-contact alarm inputs, 1000 wireless emergency call button or station transmitters, 1000 “keywords” for conditional messaging and 250 RS232 serial ports.

J. The system shall be capable of providing a “Secure Mode” design so that no other paging transmitter can activate the local wireless remote devices. The “Secure Mode” code should be programmable from the system main console.

K. The system shall be capable of providing an “Over-the-Air” programmability design. This feature shall allow programming wireless remote devices (such as wireless remote devices such as speakers, strobe lights, LED message boards and sirens) into groups/zones and setting their operation mode wirelessly from the system main console.

L. The system shall be capable of providing full supervision capabilities of all system wireless remote devices such as speakers, strobe lights, LED message boards and sirens. This feature shall allow each remote wireless device to report back its operational status, setup information and internal battery status upon wireless request from the main system.

M. The main system shall provide a voice gateway to access wirelessly controlled PA speakers individually or as a group. Real-time voice messages can be initiated via the system microphone or the telephone line interface. The messages may be initiated automatically or manually by the user.

N. The main system shall provide an “Alert Tone” voice gateway to access wirelessly controlled PA speakers individually or as a group. The messages may be initiated automatically or manually by the user.

O. The wirelessly controlled PA speakers shall include storage of at least 8 pre-recorded voice messages or alert tones. The wirelessly controlled PA speakers shall be capable of being a member of at least 8 groups or zones, with a built-in real time clock and full wireless programmability.

P. The wirelessly controlled PA speakers shall be able to play FM background music when initiated by a wireless command from the main system.

Q. The wirelessly controlled strobe lights shall be capable of being a member of at least 8 groups or zones, with full wireless programmability.

R. The wirelessly controlled alphanumeric LED message boards shall be capable of wirelessly receiving alphanumeric text messages from the main system and display them in 1 to 4 lines (model dependent). The wirelessly controlled alphanumeric LED message boards shall be capable of being a member of at least 6 groups or zones.

S. The wirelessly controlled siren horn shall be capable of being a member of at least 8 groups or zones, with full wireless programmability.

T. The wirelessly controlled speaker, strobe light or siren shall be capable of supporting built-in battery backup.

U. The wirelessly controlled speaker, strobe light or siren shall be capable of supporting PoE or Solar power option (utilizing a built-in battery backup).

V. The system shall incorporate a “fail-safe” design so that a temporary power interruption shall not cause failure of the entire system. Upon restoration of power, the system shall resume normal operation without the need to reset the system or any of its components.

W. The system shall include a notification pager and email to automatically notify a local supervisor or maintenance personnel of any system malfunction within seconds.

1.4 Submittals

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of PA controllers and speakers, strobe light controllers and strobe light lens, LED message boards and sirens.

B. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

C. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

1.7 Substitutions

A. Proposed substitutions shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date.

C. Systems requiring wiring and/or conduit between the system controller and the remote devices (such as PA controllers and speakers, strobe light controllers and strobe lights, LED message boards or sirens) or the remote devices controller will not be acceptable.

1.8 Quality Assurance

A. Permits: Obtain operating license for the transmitter from the FCC (service may be provided by Visiplex).

B. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial wireless systems with a documented experience of minimum of 10 years.

2. Installer: Company with documented experience in installation of commercial wireless systems.

2.1 Manufacturer

- A. Wireless Emergency Mass Notification and Public Address system and its components shall be manufactured by Visiplex:

Visiplex, Inc.
Buffalo Grove, IL 60089
Tel: 877-918-7243
Website: www.visiplex.com

2.2 System Operations and Startup Sequence

The VNS5100 AlertWave system is a powerful multitasking PC capable of sending both pre-programmed and real-time voice messages to specific PA speakers or designated groups of PA speakers. This message can be generated over the phone using the system's telephone interface, or generated through the system's microphone. The VSN5100 is also capable of wirelessly controlling a number of alert devices, such as strobe lights, siren horns and alphanumeric pagers. Capabilities also include the ability to send a text message to an alphanumeric LED message board as a result of a preprogrammed event or a message that was generated from the PC keyboard or a network client. The VNS5100 can also initiate mass e-mail and phone messaging to predefined personnel and occupant lists.

A. Control Center Operation:

When power is first applied to the unit, it will start the Windows boot process. Once the software is fully loaded, the main control screen is displayed and the system is ready for operation.

B. Wireless PA Speaker Operation:

- Connect the DC adaptor (supplied with each wireless controller) to AC power source.
- After few seconds of initial setup, the wireless controller LED will start flashing to indicate that all the internal circuitry is fully functioning.
- Connect a speaker to the wireless controller speaker output port using the supplied cable. The speaker is now ready to receive voice and data information from the main control center.

C. C. Wireless Strobe Light or Siren Operation:

- Connect the DC adaptor (supplied with each wireless controller) to AC power source.

- After few seconds of initial setup, the wireless controller LED will start flashing to indicate that all the internal circuitry is fully functioning.
- Connect a strobe light or siren to the wireless controller output port using the supplied cable. The device is now ready to receive wireless activation commands from the main control center.

D. Wireless Alphanumeric LED Message Board Operation:

- Connect the DC adaptor (supplied with each LED message board) to the AC power source.
- After few seconds, the alphanumeric LED message board will scroll an activity status line on the LED message board to indicate that all internal parts are working properly. After few more seconds the LED message board will be cleared until it receives new information to be displayed transmitted from the main control center. If the LED message board is set to display the time, the internal receiver will search for valid time data transmission and resynchronize to the correct time if needed.

END OF SECTION 0275315

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. RS-232 cabling.
 - 3. RS-485 cabling.
 - 4. Low-voltage control cabling.
 - 5. Control-circuit conductors.
 - 6. Fire alarm wire and cable.
 - 7. Identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

1.7 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP cable and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

2.3 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ADC.
 - 2. AMP Netconnect; a brand of Tyco Electronics Corporation.
 - 3. Belden Inc.
 - 4. Berk-Tek; a Nexans company.
 - 5. CommScope, Inc.
 - 6. Draka Cableteq USA.
 - 7. Genesis Cable Products; Honeywell International, Inc.
 - 8. Mohawk; a division of Belden Networking, Inc.
 - 9. Superior Essex Inc.
 - 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
 - 11. 3M; Communication Markets Division.
- B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, **Category 6**.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG.
 - b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX.
 - e. Multipurpose: Type MP or MPG.
 - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - g. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. ADC.
 2. American Technology Systems Industries, Inc.
 3. AMP Netconnect; a brand of Tyco Electronics Corporation.
 4. Belden Inc.
 5. Dynacom Inc.
 6. Hubbell Incorporated; Hubbell Premise Wiring.
 7. Leviton Commercial Networks Division.
 8. Molex Premise Networks; a division of Molex, Inc.
 9. Panduit Corp.
 10. Siemon.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: **110-style for Category 6**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 RS-232 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Polypropylene insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.6 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.7 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.8 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- B. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.9 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Comtran Corporation.
 - 2. Draka Cableteq USA.
 - 3. Genesis Cable Products; Honeywell International, Inc.
 - 4. Rockbestos-Suprenant Cable Corp.
 - 5. West Penn Wire.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.10 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady Worldwide, Inc.
 - 2. HellermannTyton North America.
 - 3. Kroy LLC.
 - 4. Panduit Corp.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

- A. Install wiring in metal pathways and wireways.
 - 1. Minimum conduit size shall be 3/4 inch Control and data transmission wiring shall not share conduit with other building wiring systems.
 - 2. Comply with requirements in Section 280528 "Pathways for Electronic Safety and Security."
 - 3. Comply with requirements in Section 260536 "Cable Trays for Electrical Systems."
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
 - 4. Install conductors parallel with or at right angles to sides and back of enclosure.
 - 5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
 - 6. Mark each terminal according to system's wiring diagrams.

7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
 1. Comply with TIA/EIA-568-B.1.
 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 9. Cables run underground shall be wet location rated and in PVC conduit.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with **Category 6** rating of components and that ensure **Category 6** performance of completed and linked signal paths, end to end.
 1. Comply with TIA/EIA-568-B.2.
 2. Install 110-style IDC termination hardware unless otherwise indicated.
 3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
- E. Open-Cable Installation:
 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."
 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, are permitted.
 3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
 4. Circuits run underground shall be wet location rated in PVC conduit.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- 3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS
- A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No. 14 AWG.
 2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.
- 3.6 CONNECTIONS
- A. Comply with requirements in Section 281643 "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.

- B. Comply with requirements in Section 281600 "Intrusion Detection" for connecting, terminating, and identifying wires and cables.
- C. Comply with requirements in Section 281300 "Access Control" for connecting, terminating, and identifying wires and cables.
- D. Comply with requirements in Section 282300 "Video Surveillance" for connecting, terminating, and identifying wires and cables.
- E. Comply with requirements in Section 284619 "PLC Electronic Detention Monitoring and Control Systems" for connecting, terminating, and identifying wires and cables.
- F. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.
- G. Comply with requirements in Section 283500 "Refrigerant Detection and Alarm" for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.8 GROUNDING

- A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 280528 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Surface pathways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
2. Section 270528 "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Continuous HDPE: Comply with UL 651B.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for general-use installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

2.4 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish.
- C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.
- D. Tele-Power Poles:
 - 1. Material: Aluminum with clear anodized finish.
 - 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Metal Floor Boxes:

1. Material: Cast or sheet metal.
2. Type: Fully adjustable.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are prohibited.

K. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 12, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - 1. Standard: Comply with SCTE 77.
 - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC."
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of hot-dip galvanized-steel diamond plate.
 - 1. Standard: Comply with SCTE 77.
 - 2. Color of Frame and Cover: Gray.
 - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering, "ELECTRIC."

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC, Type EPC-80-PVC.
 - 2. Concealed Conduit, Aboveground: GRC, EMT.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, Type EPC-80-PVC, direct buried. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC.
 - 6. Damp or Wet Locations: GRC.
 - 7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway or EMT.
 - 8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway, or EMT.
 - 9. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-

- fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway, Plenum-type, communications-cable pathway, or EMT.
10. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches of changes in direction.
- E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- F. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- G. Stub-ups to Above Recessed Ceilings:
1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- H. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- I. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- J. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.
- L. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.
- M. Surface Pathways:
1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
- N. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.
- O. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.
- P. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- Q. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental

- temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- S. Mount boxes at heights indicated on Drawings according to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- ### 3.3 INSTALLATION OF UNDERGROUND CONDUIT
- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
 2. Install backfill as specified in Section 312000 "Earth Moving."
 3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60

inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- C. Field cut openings for conduits according to enclosure manufacturer's written instructions.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

END OF SECTION 280528

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Magnetic door holders.
8. Remote annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level II minimum.
 - c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
- C. Field quality-control reports.
- D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment.
 - d. Riser diagram.
 - e. Record copy of site-specific software.
 - f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - g. Manufacturer's required maintenance related to system warranty requirements.
 - h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Carbon monoxide detectors.
 - 6. Automatic sprinkler system water flow.
 - 7. Fire-extinguishing system operation.
 - 8. Fire standpipe system.
 - 9. Dry system pressure flow switch.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Activate preaction system.
 - 5. Activate emergency shutoffs for gas and fuel supplies.
 - 6. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Fire alarm system design is around the Notifier NFS2-3030 fire alarm panel. Any substitutions shall be compatible and function with all ancillary components called out in the plans. In addition any substitutions shall have equivalent functionality of the specified unit. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bosch Security Systems.
2. Faraday.
3. Fike Corporation.
4. Fire-Lite Alarms.
5. GAMEWELL.
6. GE UTC Fire & Security; A United Technologies Company.
7. Keltron Corporation.
8. Mircom Technologies, Ltd.

9. Notifier.
10. Siemens Industry, Inc.; Fire Safety Division.
11. Silent Knight.
12. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 1.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

- I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AMSECO - A Potter Brand.
 - 2. Bosch Security Systems.
 - 3. Cooper Wheelock.
 - 4. Faraday.
 - 5. Federal Signal Corporation.
 - 6. Fike Corporation.
 - 7. Fire-Lite Alarms.
 - 8. GAMEWELL.
 - 9. GE UTC Fire & Security; A United Technologies Company.
 - 10. Keltron Corporation.
 - 11. Mircom Technologies, Ltd.
 - 12. Notifier.
 - 13. Siemens Industry, Inc.; Fire Safety Division.
 - 14. Silent Knight.
 - 15. SimplexGrinnell LP.
 - 16. System Sensor.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
 - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bosch Security Systems.
 - 2. Faraday.
 - 3. Fenwal Protection Systems; A UTC Fire & Security Company.
 - 4. Fire-Lite Alarms.
 - 5. GAMEWELL.

6. GE UTC Fire & Security; A United Technologies Company.
7. Gentex Corporation.
8. Harrington Signal, Inc.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Siemens Industry, Inc.; Fire Safety Division.
13. Silent Knight.
14. SimplexGrinnell LP.
15. System Sensor.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

2.7 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
 - 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Testable by introducing test carbon monoxide into the sensing cell.
 - 3. Detector shall provide alarm contacts and trouble contacts.
 - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - 5. Comply with UL 2075.
 - 6. Locate, mount, and wire according to manufacturer's written instructions.
 - 7. Provide means for addressable connection to fire-alarm system.
 - 8. Test button simulates an alarm condition.

2.8 NONSYSTEM SMOKE DETECTORS

- A. General Requirements for Nonsystem Smoke Detectors:
 - 1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 - 2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
- B. Single-Station Smoke Detectors:
 - 1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 - 2. Auxiliary Relays: One Form C, rated at 0.5 A.
 - 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 - 4. Visible Notification Appliance: 177-cd strobe.
 - 5. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
 - 6. Test Switch: Push to test; simulates smoke at rated obscuration.
 - 7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - 8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 10. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

2.9 HEAT DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bosch Security Systems.
2. Faraday.
3. Fire-Lite Alarms.
4. GAMEWELL.
5. GE UTC Fire & Security; A United Technologies Company.
6. Gentex Corporation.
7. Harrington Signal, Inc.
8. Keltron Corporation.
9. Mircom Technologies, Ltd.
10. Notifier.
11. Siemens Industry, Inc.; Fire Safety Division.
12. Silent Knight.
13. SimplexGrinnell LP.
14. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Wheelock.
2. Federal Signal Corporation.
3. GE UTC Fire & Security; A United Technologies Company.
4. Gentex Corporation.
5. Harrington Signal, Inc.
6. Keltron Corporation.
7. Mircom Technologies, Ltd.
8. Siemens Industry, Inc.; Fire Safety Division.
9. SimplexGrinnell LP.
10. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

- C. Chimes: Vibrating type.
- D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.
- E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1. Mounting: Wall mounted unless otherwise indicated.
 - 2. Flashing shall be in a temporal pattern, synchronized with other units.
 - 3. Strobe Leads: Factory connected to screw terminals.
 - 4. Mounting Faceplate: Factory finished, red.

2.11 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: **Flush** cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.
 - 3.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone lines and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

- C. Equipment Mounting: Install fire-alarm control unit on finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- F. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

- A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by engineer, authorities having jurisdiction, and the owners representative.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Demonstration to be at Owners convenience. Demonstration to be 2 hours minimum and 8 hours maximum.

3.9 MONITORING SERVICE

- A. The Contractor shall coordinate with a local Fire Alarm Monitoring company and arrange 5 years of monitoring service with the Owners approval. Cost of 5 year monitoring service will be included into Contractors bid.

3.10 MAINTENANCE INSTURCTIONS

- A. Prior to final acceptance, the Contractor shall provide four (4) complete sets of maintenance instruction manuals to the Owner.
- B. A 5 year maintenance plan shall be included with annual maintenance inspections defined by the Owner.
- C. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:
 - 1. All aspects of the system operation and maintenance shall be detailed, including a written description of the specific system design (a typical description will not be accepted), system logic diagrams, electrical wiring diagrams of all circuits, drawings illustrating equipment locations, and technical data sheets describing each piece of equipment used in the system.
 - 2. Instructions on replacing any components of the system, including internal parts.
 - 3. Instructions on periodic cleaning and adjustment of equipment with a schedule of these functions.
 - 4. A complete list of all equipment and components with information as to the address and phone number of both the Manufacturer and local supplier of each item.

END OF SECTION 283111

SECTION 283115 - ASPIRATING SMOKE DETECTION SYSTEM

PART 1-GENERAL

1.2 SCOPE

- A. This document provides specification details for Fire Alarm Aspiration Sensing Technology (FAAST) detector. All items under this specification shall comply with all applicable code requirements and manufacturer's recommendations.

1.3 APPROVALS

- A. The Aspirating Smoke Detector shall be tested, approved and/or listed by:
- B. Underwriters Laboratories (UL) S911
- C. Underwriters Laboratories Canada (ULC)
- D. Factory Mutual (FM)
- E. California State Fire Marshal (CSFM) 7259-1653:0215
- F. Maryland State Fire Marshall (MSFM) 2244
- G. VdS Approved (Europe)
- H. CSIRO (ACTIVFIRE)
- I. KFI (Korea)
- J. Underwriters Laboratories for Class I Division II, Groups A, B, C and D Hazardous Locations.

1.4 CODE, STANDARDS, AND REGULATION

- A. The aspirating smoke detector shall be installed per manufacturer's instructions, including pipe network, programming, and power requirements, and shall comply with one or more of the following codes and standards:
 - 1. National Fire Protection Association (NFPA)
 - 2. British Fire Protection Association (EN-54)
 - 3. National Electrical Code (NEC)
 - 4. UL 268: Standard for Smoke Detectors for Open Areas
 - 5. UL 268A: Standard for Smoke Detectors for Duct Application
 - 6. Local codes and standards

1.5 DEFINITIONS

A.	AHJ	Authority Having Jurisdiction
B.	ASD	Air Sampling Detector
C.	FACP	Fire Alarm Control Panel
D.	LCD	Liquid Crystal Display
E.	LED	Light-emitting Diode
F.	NICET	National Institute for Certification in Engineering Technologies
G.	VEWFD	Very Early Warning Fire Detection
H.	SLC	Signaling Line Circuit
I.	VEWFD	Very Early Warning Fire Detection
J.	SFD	Standard Fire Detection

1.6 SYSTEM REQUIREMENTS

- A. The Aspirating Smoke Detector (ASD) shall offer various classifications to include Very Early Warning Smoke Detection (VEWFD), Early Warning Smoke Detection (EWFD), and Standard Smoke Detection (SFD) settings as identified per the requirements of NFPA.
- B. The ASD shall be self-contained and monitored by a display featuring LEDs and/or LCD to include a control system utilizing microprocessor-based technology with all functions fully programmable, LED displays, alarm indications, airflow and detector faults.
- C. The system shall constantly sample air from the environment. In operation, air shall be drawn from the air sampling piping network, through a particle separator and a 30 micron filter assembly being pulled through the detection chamber by the aspirator. The system shall not rely on air currents to bring smoke to the detector. Inside the smoke detection chamber, air shall be exposed to a blue LED and infrared laser light source. Light scattered by smoke particles shall flow through the chamber and be detected by solid state receivers, which shall convert the light to an electronic signal.
- D. The ASD shall incorporate a dual light source technology system for the automatic discrimination of signals from non-fire related sources, such as dust. The system shall automatically compensate for changes in environmental conditions and the negative effect of filter contamination.
- E. The ASD shall display a series of LEDs or be visible via an interactive LCD. The ASD shall include a Reset, Isolate, and Test functions on the front of the panel. The system shall be configured by a programmer that is PC based via PipeIQ software.
- F. The program shall allow the following detector parameters to be configured:
 - 1. Up to five threshold alarm levels (Alert, Action 1, Action 2, Fire 1, and Fire 2).
 - 2. Test, reset, and isolate functions from remote locations.

3. Design pipe network and ability to calculate obscuration levels, transport times, sample hole diameters, flow and pressure levels.
 4. Shall allow the ability to program the detector to three different settings: day, night, and weekend mode.
 5. Acclimate mode shall automatically adjust alarm levels within user-specified parameters to reduce nuisance alarms.
- G. The program shall allow the ASD firmware to be updated in the field by system installers and maintainers.
- H. The ASD shall have the capability to connect to the building automation/management system via Modbus Protocol utilizing a TCP server or serial connection using RS-485.
- I. Provide local networking capability and monitoring through the onboard Ethernet connection allowing for up to six email addresses. Each address shall be configured to notify the recipient of a specific alarm level, fault level, or isolate condition.

J. Detector Performance Requirements

1. Detectors shall be tested and approved to cover up to 8,000 sq. ft. (744 sq. m)
2. Detectors shall be approved to monitor up to five alarm levels. Each level shall be programmable and able to select desired sensitivity, ranging from 0.00029%/ft – 6.0%/ft. UL approval compliance recognizes sensitivity ranges from 0.00029%/ft – 4.0%/ft.
3. Detectors shall report alarms and faults using fault relays or direct connection via the SLC loop, if applicable.
4. Detectors shall include a field-replaceable filter and an internal particle separator to reduce the amount of non-combustible materials reaching the detection chamber.
5. The software shall provide pipe design, system configuration, and system monitoring in a single software program. It shall store up to 18,000 events. Events shall include smoke levels, alarm conditions, operator actions, and faults. The date and time of each event shall be recorded.
6. The front panel of the detector shall indicate flow faults, configuration, external monitor, time, communication, trouble, filter, isolation, voltage, and high flow faults via dedicated LEDs or an LCD display.
7. The ASD shall use ultrasonic sensors to confirm proper air flow through the pipe network and produce a fault when there is a change of a user-settable percentage from nominal air flow.
8. The ASD shall store vital statistics including airflow, obscuration signal level, alarm levels, fan speed, and temperature. The frequency with which these statistics are stored shall be adjustable.

1.7 SUBMITTALS

- A. System shall be complete in all ways and shall include all engineering and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interfaces, functional testing, training, and all other operations necessary for a functional, UL Listed, and FM Approved system.
- B. Prepare product data and site drawings indicating the system layout, including location of modules, detection/aspiration unit, air intake ports, power requirements, and sample hole obscuration sensitivity level calculations.
- C. Show method and spacing of hanger supports on aspirating tube to the building structure.

- D. As-Built Drawings:
 - 1. Upon completion of the installation, the Contractor shall revise aspirating detection system design files, calculations, manuals, and operating instructions to agree with on-site conditions.
 - 2. Submit a copy of the manufacturer's installation, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Manufacturer
 - 1. The manufacturer shall have a minimum of 20 years of production experience in the manufacturing and design of smoke detection devices.
- B. Detector Requirements
 - 1. The ASD shall have dual source (blue LED and infrared laser) optical smoke detection for a wide range of fire detection, with enhanced immunity to nuisance particulates. The ASD shall operate in air flows from 0-4000 ft/min (0-1,219 m/min). The system software shall provide pipe design, system configuration, and system monitoring in a single software program.
 - 2. The ASD shall offer Very Early Warning Smoke Detection, Early Warning Smoke Detection, and Standard Smoke Detection settings. The ASD shall offer a wide range of sensitivity settings from 0.00029%/ft – 4.0%/ft. The detector shall be capable of operating in temperatures from 32°F (0°C) to 100°F (38°C). Sampled air temperatures shall range from -4°F (-20°C) to 140°F (60°C). Operating humidity shall range from 10-95% non-condensing.
- C. Installer
 - 1. The equipment installer shall be authorized and trained by the manufacturer and shall have the ability to design a system based on code requirements. The installer shall be capable of providing calculations, design, and testing documents upon request. The contractor shall procure design software (Pipe IQ software) and lay out all sensing ports in the pipe runs.

PART 2 - PRODUCT

2.2 MANUFACTURER

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

System Sensor – Fire Alarm Aspirating Sensing Technology (FAAST)

System Sensor (Headquarters)
3825 Ohio Avenue
St. Charles, IL 60174
- B. Manufacturer Approved Units:
 - 1. FAAST XM Detector coverage area up to 8,000 sq. ft. (744 sq. m)

2.3 ASPIRATING SMOKE DETECTOR

- A. The ASD shall allow up to 5 programmable alarm levels with time delays, including Alert, Action 1, Action 2, Fire 1, and Fire 2. The ASD shall allow for Acclimate or Day/Night/Weekend settings to accommodate environmental changes. The Acclimate mode shall automatically adjust alarm levels within user-specified parameters to reduce nuisance alarms. It shall continually adapt to current environmental conditions when activated. Day/Night/Weekend settings shall allow the user to create specific thresholds and delays during the day, night, or weekend.
- B. The ASD shall provide up to 8 form C, programmable, latching or non-latching relays or the ability to connect directly to the FACP via the SLC. It shall include a field-replaceable filter and an internal particle separator to reduce the amount of non-combustible materials reaching the detection chamber. It shall be tested and approved for coverage up to (8,000 sq. ft. /744 sq. m). The unit shall use ultrasonic sensors to confirm proper air flow through the pipe network and store up to 18,000 events. Events shall include smoke levels, alarm conditions, operator actions, and faults. The date and time of each event shall be recorded.

2.4 DESIGN PARAMETERS

- A. The ASD design shall comply with all national and local code requirements and UL and FM approved listings. The ASD shall be designed with the following parameters:
 - 1. NFPA Classifications:
 - a. SFD: Standard Fire Detection. The sample port spacing shall not exceed 900 sq. ft. (83.7 sq. m) and shall initiate an alarm/alert in less than 120 seconds from the furthest sample port. The detector shall be programmed to alarm at 2.0% obscuration per foot at the sample port for Fire 1 setting.
 - 2. Sampling point flow and pressure requirements:
 - a. Minimum Flow: 2 L/min.
 - b. Minimum Pressure: 25 Pa
- B. A test port shall be provided at each pipe run located at 18" above the finished floor for under floor systems, or 5ft above the finished floor when pipe network is above the ceiling. The test port shall be constructed using a vented end cap. Provide a decal indicating the install date, detector zone, pipe number, test point ID, transport time and suction pressure (Pa).
- C. Provide appropriate number of ASD apparatuses to efficiently and adequately cover designated area(s).

INTELLIGENT FIRE ALARM CONTROL PANEL CONNECTIVITY

- D. The ASD shall be capable of connection to an Intelligent Fire Alarm Control Panel (FACP) via a Signaling Line Circuit (SLC) using the communications protocol native to the system, without the use of any additional hardware. The FACP shall be capable of monitoring and annunciating one trouble condition and one alarm condition.
- E. The following operations shall be able to be performed on the ASD via the FACP:
 - 1. Disable/enable reset airflow baseline,
 - 2. Reset.
- F. Trouble conditions annunciated at the FACP shall include indications for: Low air flow, configuration (programming) fault, device in service mode, communications loss, time lost or not set, aspiration fault, filter fault, high air flow fault, detector fault, detector initializing warning, and power fault.

2.5 MONITORING:

- A. The ASD shall provide up to three Fault types to indicate the priority of faults generated in the system. Fault indication shall be provided for the following:
 - 1. Low flow – If the device has decreased in air flow, a Fault shall be generated at a user-settable decrease in air flow.
 - 2. High flow – If the device has increased in air flow, a Fault shall be generated at a user-settable increase in air flow
 - 3. Configuration – Device configuration failure. A Fault shall be generated if a configuration update did not transfer.
 - 4. Sensor – If the particulate sensor is not operating properly and needs immediate replacement, a Fault shall be generated.
 - 5. External Monitor – If the external monitor detects an open a Fault shall be generated.
 - 6. Time – If the internal time base needs to be updated, a Fault shall be generated.
 - 7. Communication – If the device fails to communicate to one of its peripherals and cannot function properly, a Fault shall be generated.
 - 8. Aspiration – If the aspirator is not working and requires immediate attention, an Fault shall be generated.
 - 9. Filter – As the filter approaches a pre-set threshold, an initial warning shall be given to change the filter and a Fault shall be generated.
 - 10. Isolate – If the device is put into the Isolate mode, an Isolation fault shall be generated.
 - 11. DISPLAYS
- B. The system shall provide a user interface at the front of the detector with the following displays:
 - 1. Air Flow/Fault Display – The air flow/fault display shall consist of 10 bicolor LEDs and operate in one of two modes: air flow or fault indication. Green segments shall indicate how close the current air flow is to the high or low air flow threshold. The default threshold for a fault condition is + or – 20% from the airflow baseline. During normal operation two adjacent indicators shall be green and correspond to the current airflow entering the detector. When airflow is at a balanced level, the two green segments shall be centered on the graph. As airflow rises and falls, the green segments shall move right and left accordingly. If a fault is activated on the device, the corresponding LEDs shall

- illuminate in amber and an additional “fault” LED shall be triggered to signal a fault has been generated. All 10 faults shall be indicated on the User Interface.
 2. 10 particulate levels – The particulate level display shall consist of ten amber LEDs that correspond to the current level of the particulate detected. The LEDs shall illuminate in order from Level 1 to Level 10, starting from the bottom of the display and moving up as the particulate level increases. Each LED shall represent a 10% increase in the particulate level necessary to reach the Alert Alarm level.
 3. (3) 5 alarm levels – All (3) 5 Alarm levels shall be indicated on the User Interface. The Alarm Level Display shall consist of (3) 5 red LEDs that correspond to the current alarm level. These LEDs shall be located directly above the Particulate Level LEDs. They shall illuminate sequentially upward as the severity of the alarm increases.
 4. On/Off indication
 5. Low Voltage indication
- C. The user interface shall offer an interactive panel. The panel shall have a security passcode system to prevent unauthorized access if chosen. The panel shall allow the following features to be activated at the device:
1. Test
 2. Reset
 3. Isolate
 4. Information Generation – the detector shall provide the local device address and the IP address of the device through a coded sequence or via the LCD interactive function.
 5. Password input if required to activate detector.
- D. Liquid Crystal Display for FFAST XS and XT models shall provide detailed information of the device status and configuration. The LCD will enter a sleep state if the screen has remained unchanged for a period of 30 seconds. The home screen shall display the device’s current state which includes local address, date, time, current percent of smoke, and the highest priority state. The LCD shall support multiple languages. Navigation through the menus shall be done with the keypad located on the right hand side and shall be able to perform the following functions:
1. Isolate
 2. Disable
 3. Reset Baseline
 4. Monitor Airflow per pipe
 5. Test
 6. Sounder Test
 7. Reset IP Network
 8. Password input if required to activate detector.

2.6 SOFTWARE

- A. The software shall be based on a single program, PipeIQ, which provides pipe network design, ASD configuration, and system monitoring. The software shall provide the ability to remotely monitor the system and provide the following functions:
1. Test, reset, and isolate functions from remote locations
 2. Bill of Materials for the pipe network
 3. Pipe layout of the pipe network
 4. Generate transportation time from the sampling holes to the detector and sampling hole pressure
 5. Live event monitoring

6. Historic event retrieval
7. Custom message function to input messages about a device or site
8. Configuration settings
9. Network settings
10. Trend graph reflecting obscuration over time
11. Shall support up to 255 devices.

2.7 NETWORK CONNECTIVITY

- A. The ASD shall include an onboard Web server interface to enable remote monitoring. Connection to the device shall be through an RJ45 Ethernet jack. A password shall be required to access the Web server. The software shall include the ability to enter up to six (6) e-mail addresses to send automatic updates for alarms and/or faults. Each e-mail address shall have the ability to select the type of notification desired.
- B. The ASD shall communicate Modbus protocol using the onboard Ethernet connection. The device shall be able to receive remote configuration, as well as be monitored remotely, when the Modbus function is employed.
- C. The Modbus/TCP communications shall be enabled through port 502 without inhibiting the functions of the PipeIQ server, the e-mail service (port 25), or the device's integral web server. Each of these communication capabilities shall be available simultaneously.
- D. Modbus communications shall be enabled without inhibiting the functions of the PipeIQ server or the device's integral web server. Each of these communication capabilities shall be available simultaneously.

2.8 SAMPLE PIPE NETWORK

- A. The ASD shall consist of a pipe network to transport air to the detection system supported by calculations from a computer-based design modeling tool.
 1. The internal pipe diameter of the network may range from 0.59 inches to 1.03 inches (15-26 mm) with a smooth bore internal surface.
 2. The ASD shall accept both nominal 3/4 inch and 25 mm pipe diameters.
 3. Inflow and Exhaust pipes shall enter the device from either the top or the bottom of the unit so that the unit does not have to be inverted.
 4. The system exhaust must be located back into the room being monitored. If the ASD is located within the same room being monitored, no exhaust pipe is required to be connected to the ASD.
 5. Material for pipe and fittings shall be chlorinated polyvinyl chloride (CPVC) PIPE. The pipe shall be UL Listed as an accessory for plenum use as per UL 1887 standard.
 6. The pipe shall be identified as "Smoke Detector Sampling Tube" along its entire length, in requirements per local codes and standards and manufacturer's recommendations.
 7. Pipe material substitution may be acceptable to accommodate environments where pipe network will be installed but must be approved by the specifying engineer and authority having jurisdiction, and if applicable, insurance underwriters.
 8. The substitution pipe must comply with both inner and outer pipe diameter requirements.
 9. All joints and sampling pipes must be glued and connected, free of any air gaps using solving cement throughout the pipe network, with the exception of the pipe connected to detector.

B. FAAST XM

1. The pipe network shall be designed based on a multi-branch system from a single pipe inlet. The system shall have the ability to cover up to 8,000 sq. ft. (744 sq. m) per detector. Final square footage shall be based on classification requirements per NFPA.
2. A single pipe network cannot exceed a maximum of 262 linear ft (80 m) on a single run and 450 ft (137 m) on an aggregate pipe network. Final pipe lengths shall be verified with PipeIQ software and comply with NFPA classifications.

2.9 SAMPLING PORT

- A. Sample port spacing shall comply with the requirements of NFPA classifications and manufacturer's recommendations.
- B. The minimum sample port diameter must not be less than 5/64" and shall not exceed a diameter larger than 1/4".
- C. All sample ports must be identified in accordance with NFPA.
- D. In areas with a suspended ceiling the pipe network shall be installed above the ceiling utilizing a 3/8 inch diameter, flexible capillary tubing attached to an approved manufacturer's capillary sample port supported by the ceiling.
- E. The size of sample ports shall be verified and confirmed with PipeIQ calculations software.

2.10 SYSTEM OPERATING POWER

- A. Provide power supply/charger to convert 115 VAC/60 Hz input into a single 12 VDC or 24 VDC Class 2 Rated power limited output, with UL listing UL1481.
- B. Power supply shall be provided with appropriately sized batteries to accommodate the system's power requirements in the event main AC power is interrupted.
- C. Upon loss of AC power, the external battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm.

2.11 FILTER ASSEMBLY

- A. Internal non-replaceable particle separator shall remove larger contaminants before entering the detection chamber and filter.
- B. Multi-stage 30 micron field-replaceable filter. A fault shall be generated when the filter needs replacement due to a reduction of air of more than 20%.

2.12 WIRING

- A. Wire gauge shall range from 24 to 12 AWG (0.5-2.05 mm). Wire or conduit shall enter the detector from either the top or the bottom of the device. Pluggable terminals shall be used to wire the detector.

PART 3 - EXECUTION

3.2 EQUIPMENT INSTALLATION

- A. The entire system shall be installed in accordance with national and local codes and per the manufacturer's installation manual.
- B. Aspirating Smoke Detector Installation
 - 1. ASD shall be mounted on a secured wall as per detail 2 and 4 /E5.00
 - 2. ASD shall be located in an unobstructed location and shall maintain 36 inches (0.9 m) clearance in front of the unit.
 - 3. All pipes and fittings shall be glued using solvent cement, except at entry of the ASD.
- C. Sampling Pipe Network
 - 1. Sampling pipe network shall be installed and designed so that the transport times from the most remote sample port location complies with the classifications of NFPA; (SFD).
 - 2. Sampling pipe shall be installed within 4 to 12 inches (0.1-0.3 m) from the ceiling in smooth ceiling applications.
 - 3. All pipes shall be supported by mechanical hangers attached to the structure of the building, at no greater than five foot centers.
 - 4. All pipes must be labeled throughout its entire length, as required per NFPA.
 - 5. Piping network(s) shall be installed/design to provide detection points and spacing as indicated on the drawings (or as required). All changes to the direction of the pipe shall be made with standard elbows or tees. Piping shall be verified per manufacturer's modeling software.
- D. Sampling Port
 - 1. Sample port spacing shall comply with the requirements of NFPA classifications and manufacturer's recommendations.
 - 2. All sample ports shall be drilled directly at the bottom of the pipe and equal the diameter as indicated per the PipeIQ reports.
 - 3. In high air flow environments being used as plenums the sample ports must be aligned at angle between 20 to 45 degrees in the direction of the airflow, as per manufacturer's recommendations.

3.3 SYSTEM INSPECTION:

- 1. Perform a visual inspection of the physical installation, checking adequate size batteries are used, piping is securely connected and installed, and all sample ports comply with the design.
- 2. Verify ASD communicates to fire alarm control, and if applicable, has the ability to network via a dedicated IP address and Modbus protocol.

3. Check the controller to ensure the following functions are operational and programmed in accordance with the specification:
 - a. Alarm Levels and Indicators
 - b. Time Delays
 - c. Particulate Level Display
 - d. Detector Fault Test Indicator
 - e. Detector Test and Indicator
 - f. Isolate/Reset Function
 - g. Air Flow Fault Indicators
 - h. Configuration Fault
 - i. Sensor Fault
 - j. External Monitor Fault
 - k. Time Fault
 - l. Communication Fault
 - m. Aspirator Fault
 - n. Filter Fault

3.4 COMMISSIONING

- B. The system shall be commissioned in the presence of the manufacturer trained installing contractor representative and client representative. The contractor shall provide the following necessary instrumentation, equipment, materials, and labor for the test:
 1. PipeIQ Pipe Layout Report
 2. Aerosol smoke (Home Safeguard Industries Model 25S or equivalent)
 3. Stopwatch capable of measuring 1 second intervals
 4. A total of two (2) factory qualified personals when testing is being performed

- B. Acceptance testing shall be conducted in front of specifying engineer or client representative, and in front of the Authority Having Jurisdiction using the following testing methods:
 1. Introduce canned smoke (Home Safeguard Industries Model 25S or equivalent) directly into the sampling hole in to farthest sample hole for a duration of 2 seconds at a distance of 6 inches from the sample hole. Start the timer once the smoke has been introduced.
 2. Stop the timer once the first particulate bar is illuminated on the front of the device, above what was displayed during normal device operation. The device need not go into alarm to verify the transport time – an increase on the particulate meter is a successful measurement of transport time.
 3. Compare the observed transport time with the results on the Pipe Layout report from PipeIQ. If there is more than a 20% discrepancy, verify the sample hole quantity, sizes, location, and the integrity of pipe and that the installed pipe network is identical to the PipeIQ Pipe Layout report.
 4. Once transport times for the farthest sample points are verified, test the remaining holes for airflow by introducing smoke into each hole and verifying a response at the device or panel. Transport times are not required on each of the remaining holes, only a verification that air is flowing.

5. Document test results as required per NFPA to include the client's contact information, transport times, and sensitivity levels.
6. Upon completion of a successful test, installer shall so certify the system in writing to Owner's Representative.

3.5 MAINTENANCE AND TESTING

- A. The ASD system shall be maintained and tested as required per manufacturer's recommendations.
- B. Annual testing of the ASD shall be conducted as required per NFPA requirements. The system shall be verified that transport times meet the intended classification. All alarm levels and communication to the FACP shall be tested to insure integrity of the system.
- C. Maintenance to the pipe network shall be conducted when the filter needs replacement or in harsher environments periodically to avoid clogging of the tubing. The time frame shall be determined based on the flow characteristics of the detector or schedule maintenance as required by the facility.
- D. Upon maintaining the pipe network an isolation ball valve and tee fitting with an end cap of the suction side on the sampling pipe shall be installed approximately 6 inches to 1 foot (15cm to 30cm) from the ASD.
 1. The detector must be placed into either disable or isolation mode when cleaning out the pipe network.
 2. The isolation valve must be closed when conducting pipe maintenance.
 3. The end cap on the maintenance tee fitting shall be removed and a vacuum shall be connected to remove debris from within the pipe network.

3.6 TRAINING

- A. CONTRACTOR QUALIFICATIONS
 1. All contractors involved with the design and installation of ASD systems shall be very experienced with the systems that they are designing / installing per the occupancy use. A minimum of 5 years experience in the installation of fire alarm systems and a NICET level III fire alarm technician or equivalent on staff to supervise the design and installation is required.
 2. The installing contractor shall have passed the manufacturer certification training and be certified to model, design, install, program, test and maintain the ASD system and shall be able to produce a certificate stating such upon request.
 3. The installing contractor shall maintain appropriate licensing and certifications from the jurisdiction in which the work occurs.

3.7 WARRANTY

- A. The manufacturer shall guarantee the product by warranty for a period of three years. All components of the detector shall be replaced with the exception of regular maintenance accessories: replaceable micron filter. Any damage to the ASD due to poor handling or operating outside of the listed criteria will void any such warranty. The installation and programming of the ASD shall be completed by factory-trained installer.

3.8 MAINTENANCE INSTRUCTIONS

- A. Prior to final acceptance, the Contractor shall provide four (4) complete sets of maintenance instruction manuals to the Owner.
- B. A 5 year maintenance plan shall be included with annual maintenance inspections defined by the Owner.
- C. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:
 - 1. All aspects of the system operation and maintenance shall be detailed, including a written description of the specific system design (a typical description will not be accepted), system logic diagrams, electrical wiring diagrams of all circuits, drawings illustrating equipment locations, and technical data sheets describing each piece of equipment used in the system.
 - 2. Instructions on replacing any components of the system, including internal parts.
 - 3. Instructions on periodic cleaning and adjustment of equipment with a schedule of these functions.
 - 4. A complete list of all equipment and components with information as to the address and phone number of both the Manufacturer and local supplier of each item.

3.9 MONITORING SERVICE

- A. The Contractor shall coordinate with a local Fire Alarm Monitoring company and arrange 5 years of monitoring service with the Owners approval. Cost of 5 year monitoring service will be included into Contractors bid.

3.10 OWNER TRAINING

- A. Train Owner's maintenance personnel to adjust, operate and maintain ASD systems.
- B. Prior to final acceptance, the installing contractor shall provide operational training to each shift of Owner's personnel. Each training shall include ASD system operation, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures.

END OF SECTION

SECTION 284631 – LINEAR HEAT DETECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish all labor, equipment, and materials, and perform all operations in conjunction with the installation of the Linear Heat Detection System for Montana FWP at Bannack State Park 4200 Bannack Rd. Dillon, MT, as indicated and described in this Specification.
- B. At the time of bid, all exceptions taken to these Specifications, all variances from these Specifications, and all substitutions of operating capabilities or equipment called for in these Specifications shall be listed in writing and forwarded to the engineer. Any such exceptions, variances, or substitutions which were not listed at the time of bid and are identified in the submittal shall be grounds for immediate disapproval without comment.
- C. Any equipment proposed as equal to that specified herein shall conform to the standards herein, and the Manufacturer must supply proof of having produced similar equipment, now giving satisfactory service. In addition, the Contractor must obtain the engineers approval in writing ten (10) calendar days prior to bidding equipment other than specified. The Manufacturer's name, model numbers, and three (3) copies of working drawings and engineering data sheets shall be submitted for approval. Included in the submittal shall be a written statement, indicating compliance with the features, functions, and performance of the specified equipment.

1.2 QUALITY ASSURANCE

- A. Retain this article with "Seismic Qualification Certificates" Paragraph in "Submittals" Article for projects requiring seismic design. Model building codes and SEI/ASCE 7 establish criteria for buildings subject to earthquake motions. Verify requirements of authorities having jurisdiction.
- B. Each component of the Fire Alarm System shall be Factory Mutual Approved and/or Listed as a product of a single fire alarm system Manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "FM" and/or "UL" labels.
- C. The equipment furnished under this Specification shall be provided by a fire alarm system supplier who has been providing this type of equipment for the past five years. The system supplier shall have a service organization capable of providing a service technician at Bannack, Mt. within 24 hours of a request for on- site service.
- D. All control equipment shall have transient protection devices designed to comply with UL864 requirements.
- E. All materials and equipment shall be new and unused.
- F. All equipment supplied shall be first quality, and the Manufacturer's best type and latest model. Obsolete equipment shall not be used.
- G. Before construction begins on the fiber optic linear heat detection system, all of the contractors employees that will be installing the system must take the factory training course and be certified to install this system. Provide certification paperwork as a submittal document.

- H. At the completion of the installation, the contractor shall provide factory commissioning of the system before acceptance. This is paid by the contractor as part of the bid.

1.3 SCOPE

- A. General - The work covered by this Specification will include the following work to be performed by the Contractor at Bannack, MT..
 - 1. Complete installation of a Linear Heat Detection Fire Alarm System on Client Facility at the Client Name.
 - 2. Testing of the complete Linear Heat Detection Fire Alarm System for alarm, trouble, and supervisory functions upon completion of the installation.
 - 3. Coordinating and conducting the demonstration test.
 - 4. Coordinating and conducting fire department acceptance test.
- B. The Contractor shall furnish, install, test, and place into full operating condition a complete, 24 VDC closed-circuit, electrically supervised, Linear Heat and Fire Detection System, as specified herein, and indicated on the drawings. The system shall include, but not be limited to, all control and communication equipment, power supplies, signal initiating devices, audible and visible notification appliances, activation of Other, connection to the municipal fire alarm circuit, conduit, wire, fittings, and all other accessories required to provide a complete and operable control system.
- C. The work described herinafter, and as indicated on the drawings and associated documents, shall consist of all labor, materials, services, software, programming, and testing required to provide a complete and operating system.
- D. All devices shall be installed and wired in accordance with the Manufacturer's instructions. The plans and associated documents provided with this Specification are presented for estimation purposes only; it is the responsibility of the Contractor to visit the site, acquaint themselves with existing conditions, and determine the required quantities of devices and specific optimum locations.

1.4 QUALIFICATIONS OF BIDDERS

- A. All Contractors connected with the captioned project shall provide proof of competence of both their company and the individual foreman assigned to this project. The shall demonstrate, in a manner acceptable to the engineer, proficiency in installing fire detection, alarm, and control systems for at least five years.
- B. The Contractor shall have been in the business of installing linear heat detection, alarm, and control systems for at least two years and shall provide documentation indicating recent projects of similar size where the Contractor was responsible for providing the complete installation of fire detection, alarm, and control systems.
- C. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

The Protectowire Company, Inc., Hanover, Massachusetts 02339, USA, 781-826-3878.
- D. Distributors of acceptable Manufacturer's equipment shall provide documentation indicating that they are authorized by the Manufacturer to distribute and service the equipment, and that the Manufacturer has stated that they have satisfactorily completed all training courses offered by the Manufacturer in relation to the equipment provided.

- E. All Contractors shall provide documentation indicating that they are authorized by the Manufacturer to install and service the equipment, and that the Manufacturer has stated that they have satisfactorily completed all training courses offered by the Manufacturer in relation to the equipment provided.
- F. The Manufacturer or its authorized distributor shall confirm that, within reasonable distance of the job site, there is an established agency which stocks a full complement of parts and offers service during normal working hours on all equipment to be furnished and that the agency will supply parts without delay and at reasonable cost.
- G. The Manufacturer or its authorized distributor shall confirm that it has the capability to provide on-site emergency service within twenty-four (24) hours of notification of the requirement for such service.

1.5 CODES AND STANDARDS

- A. All equipment, devices, cables, etc., shall be Listed by Underwriters Laboratories and/or Approved by Factory Mutual for use in Fire Protective Signaling Systems under the following standards as applicable:
 - 1. UL 864 Control Units for Fire Protective Signaling Systems.
 - 2. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
 - 3. UL 268A Smoke Detectors for Duct Applications.
 - 4. UL 521 Heat Detectors for Fire Protective Signaling Systems.
 - 5. UL 228 Door Closers-Holders for Fire Protective Signaling Systems.
 - 6. UL 464 Audible Signaling Applications.
 - 7. UL 1638 Visual Signaling Appliances.
 - 8. UL 38 Manually Actuated Signaling Boxes.
 - 9. UL 346 Waterflow Indicators for Fire Protective Signaling Systems.
 - 10. UL 1481 Power supplies for Fire Protective Signaling Systems.
- B. All other equipment shall be Listed by Underwriter's Laboratories and/or Approved by Factory Mutual.
- C. The system shall comply with all state and local codes with no exception.
- D. The installation shall be made in accordance with the applicable provisions of the latest published edition of the following:
 - 1. National Fire Protection Association Standard 101, Life Safety Code.
 - 2. National Fire Protection Association Standard 70, National Electrical Code.
 - A. Article 210, Branch Circuits.
 - B. Article 760, Fire Protective Signaling Systems.
 - C. Article 500, Hazardous Areas.
 - 3. National Fire Protection Association Standard 72, National Fire Alarm Code.
 - 4. Factory Mutual Loss Prevention Data Sheet 5-40 Protective Signaling Systems.
 - 5. Factory Mutual Loss Prevention Data Sheet 5-43 Auxiliary Protective Signaling Systems.
 - 6. The equipment Manufacturers' guidelines.

- E. The system shall be tested in accordance with the latest edition of the following:
 - 1. National Fire Protection Association Standard 72, Chapter 7, National Fire Alarm Code.
 - 2. The equipment Manufacturer's guidelines.
- F. The final system shall receive an Underwriters Laboratories Field Certification from an alarm service company authorized to issue Underwriters Laboratories certificates.

1.6 RELATED DOCUMENTS

- A. Drawings and related documents supplied with this Specification shall be used by the Contractor as a guideline for the requirement for, and location of, the system components. It shall be the responsibility of the Contractor to visit the site, acquaint themselves with existing conditions, and determine the required quantities of devices and specific options on locations.
- B. The requirements of building permits and authorities to proceed shall become a part of this Specification. The building permits and authorities to proceed shall be obtained by the Contractor, where applicable.
- C. Prior to commencement and after completion of work, the Contractor shall provide written notification to the authorities having jurisdiction.
- D. The Contractor shall notify the Owner and the Owner's Designated Representative, in writing, when the system is ready for the demonstration test. The system shall be considered ready for the demonstration test only after all preliminary tests have been made by the Contractor and the Manufacturer's technical representative, and all deficiencies have been found and corrected. In addition, two (2) copies of a report, prepared by the Contractor and the Manufacturer's technical representative and signed by them, attesting that the system is in completely satisfactory and operable condition, must be submitted to the Owner's Designated Representative before the Owner will agree to the scheduling of the demonstration test.
- E. The Contractor shall notify the Owner, the Owner's Designated Representative, and the fire department, in writing, when the system is ready for the fire department Acceptance Test. The system shall be considered ready for the fire department Acceptance Test only after the successful completion of the demonstration test and successful operation throughout the burn-in period.

1.7 ORDER OF PRECEDENCE

- A. Should conflicts arise out of discrepancies between documents referenced in this Specification, the more stringent requirement shall apply; however, should a level of stringency be undeterminable, the discrepancies shall be resolved as follows:
 - 1. State and local codes shall take precedence over all documents.
 - 2. The National Fire Protection Association Standards shall take precedence over this Specification.
 - 3. Applicable insurance underwriter's standards shall take precedence over this Specification.
 - 4. This Specification shall take precedence over the drawings.

1.8 SUBMITTALS

- A. The Contractor shall submit to the Owner and the Owner's Designated Representative sufficient information to describe their qualifications, the work efforts to be performed, and the materials to be provided. The Contractor shall certify that he/she has reviewed the documentation to verify: dimensions;

quantities; installation and fabrication techniques, procedures, and sequences; and good workmanship and safety precautions; and that they are in conformance with this Specification.

- B. These reviews are not the responsibility of the Owner, nor the Owner's Designated Representative. The Owner and the Owner's Designated Representative will only review these documents for the limited purposes of checking for general compliance with the information provided in the contract documents and general conformance with the design concept of this part of the project; not to determine accuracy or completeness of other details, such as dimensions and quantities. The Owner and the Owner's Designated Representative will not approve means, methods, or procedures of construction or installation, nor will they review for safety precautions. Accuracy and process are the responsibility of the Contractor.
- C. Two sets of submittals are required. One set shall be submitted with the bid, and the other set shall be submitted prior to performing work.
- D. As a minimum, each Contractor shall include the following submittals with their bids.
 - 1. Supplier's qualifications, indicating years in business, service capabilities and policies, warranty definitions, spare parts support, and a list of similar installations.
 - 2. Contractor's qualifications, indicating years in business and prior experience with installations that include the type of equipment that is to be supplied.
 - 3. The name of all Subcontractors and their qualifications, indicating years in business and prior experience with installations that include the type of equipment that is supplied.
 - 4. All pertinent information regarding the reliability and operation of the equipment to be supplied.
 - 5. Delivery dates of the equipment to be supplied.
 - 6. Manufacturer's original catalog data and descriptive information for all major components of the system.
 - 7. The Owner or the Owner's Designated Representative, at their sole choice and discretion, may request a demonstration of the proposed equipment.
 - 8. Equipment other than specified will be considered for approval. It shall be the Contractor's obligation to submit data and information to allow the Owner's Designated Representative time to consider the equality of the substituted items to that specified. It is the Contractor's responsibility to meet the entire intent of the specifications. Deviations from the specified items shall be at the risk of the Contractor until the date of final acceptance by the Owner and the Owner's Designated Representative. Accepted submittals on substitute equipment shall only allow the Contractor to proceed with proposing a substituted item and shall not be considered equal until such time as the Owner and the Owner's Designated Representative have completely accepted the substitute item. The Contractor shall provide the following in writing to the Owner's Designated Representative ten (10) days before the bid closing date:
 - A. A complete riser diagram of the proposed to be substituted fire alarm system.
 - B. All pertinent information regarding the reliability and operation of the equipment proposed to be substituted.
 - C. Manufacturer's original catalog data and descriptive information for all components of the system proposed to be substituted.
- E. The award of the contract will be based on the pre-award submittals. Once the contract is awarded, no changes for equipment, suppliers, or subcontractors will be accepted.

1. The Contractor shall be at risk for any attempt to substitute the equipment suppliers or subcontractors accepted. All costs, including those for removal, relocation, or replacement of a substituted item, shall be at the risk of the Contractor.
 2. Upon written request from the Contractor, the Owner and the Owner's Designated Representative may authorize changes, but at their sole choice and discretion.
 - A. It is the Contractor's responsibility to meet the entire intent of the Specification. If any attempt is made to substitute another product or brand for that product and brand of equipment specified, it shall be the Contractor's obligation to submit the above data and information to allow the specifying Engineer time to consider the equality of the substituted items to that specified.
 - B. Deviations from the specified items shall be at the risk of the Contractor until the date of final acceptance by the Engineer, and Owner's Designated Representative. Approved submittals on substitute equipment shall only allow the Contractor to proceed with installing a substituted item and shall not be considered equal until such time as the Engineer, and the Owner's Designated Representative have completely accepted the substitute item. All costs, including those for removal, relocation, or replacement of a substituted item, shall be at the risk of the Contractor.
- F. As a minimum, the awarded Contractor shall submit two (2) copies of the following prior to performing any work:
1. A schedule indicating the installation sequence, the time frame, and details on how the fire alarm control panel activation and switch-over will occur. This schedule shall ensure that system down-time is kept to a minimum. Projected dates of delivery of the equipment to be supplied, installation completion, demonstration test and final test/acceptance dates shall be included.
 2. Shop drawings which shall include original Manufacturer's specification and installation instruction sheets. All equipment and devices on the shop drawings to be furnished under this contract shall be clearly marked in the specification sheets. If any equipment and/or devices required in the system are not so marked, the Owner's Designated Representative shall mark the sheet, and this equipment and/or devices shall be made part of the system and shall be provided.
 3. A riser diagram of the complete fire alarm control system.
 4. A complete point-to-point fire alarm control equipment installation diagram; typical wiring diagrams are not acceptable.
 5. A complete list of electrical current requirements during normal, supervisory, trouble, and alarm conditions for each component of the system.
 6. Battery standby calculations showing total standby power and length of service required to meet the specified system requirements.
 7. Battery calculations showing total alarm power required to meet the specified system requirements.
 8. Sufficient information so that the exact function is known of each installed device.

- G. The Contractor shall not order any equipment, nor perform any installations, prior to completion of review of the submittals by the Owner and the Owner's Designated Representative and receipt of a written authority to proceed to the next milestone from the Owner.

PART 2 - EXECUTION

2.1 SYSTEM FUNCTION

A. GENERAL

1. The system shall provide new control equipment which is UL Listed and/or FM Approved for compatibility with all devices to be used on the system, and will provide contacts to interface to the system transmitting an alarm to the fire department or central receiving station, alert building occupants, supervise each system for conditions which would impair proper system operation, annunciate such abnormal conditions, and control related equipment, as indicated on contract documents
2. The system shall be designed such that alarm indications override trouble conditions.

B. Alarm Condition

1. The system operation shall be such that the alarm operation of any alarm initiating circuit shall not prevent the subsequent alarm operation of any other initiating circuit
2. The system alarm operation subsequent to the alarm activation of any initiation device shall automatically perform the functions contained in this section.

A. Provide Fire Alarm Control Panel Indication

1. Alarm conditions shall be immediately displayed on the control panel by a general alarm LED. The General Alarm LED shall illuminate on the control panel until the alarm has been acknowledged. A subsequent alarm received AFTER acknowledgement shall illuminate the general alarm LED.
2. Zone alarm conditions shall be immediately displayed on the control panel. Once the alarm has been acknowledged, the zone alarm LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the respective zone alarm LED on the control panel, and the panel display shall show both the new and old alarm information.
3. If the audible alarm signals are silenced for any reason, they shall automatically resound if another alarm zone is tripped.
4. When the alarm signals are silenced by pressing the Acknowledge pushbutton on the control module, the visual lamps shall continue to flash until the alarm is cleared and the control panel reset.

B. Activate Notification Appliances

1. Operate audible notification appliances in all areas.
2. Operate visual notification appliances in all areas.

3. Any subsequent alarm shall reactivate the audible and visual signals.
4. All alarm signals shall be automatically "locked in" at the control panel until the operated device is returned to its normal condition and the control panel is manually reset.

C. Auxiliary Functions

1. All auxiliary functions shall be connected to, and operated by, the control panel.
2. Upon the initiation of an alarm condition, the system shall notify the fire department.
3. Fire pump/ generator shall be started.

C. Trouble Conditions

- A. Failure of normal power, opens on the initiation circuits, opens or shorts on the notification appliance circuits, disarrangements in field system wiring, or system ground faults shall activate a trouble circuit.
- B. When a trouble condition is detected, the following functions shall immediately occur:
 1. An amber "SYSTEM TROUBLE" LED shall flash and the system audible signal shall intermittently sound when any trouble is detected in the system.
 2. A trouble signal shall be acknowledged by actuating an "ACKNOWLEDGE" switch. This shall silence the panel trouble buzzer.
 3. During an "alarm" condition, all "trouble" signals shall be inhibited.
- C. Unacknowledged alarm messages shall have priority over trouble messages, and if such an alarm occurs during a non-related trouble sequence, the alarm condition shall have display priority.

D. System Supervision

1. All wiring extending from the fire alarm system control panel enclosure to system components shall be supervised for opens, shorts and/or grounds.
2. The occurrence of any fault shall activate the system trouble circuitry, but shall not interfere with the proper operation of any circuit that does not have a fault condition.
3. Incoming line power shall be supervised so that any power failure shall be audibly and visually indicated at the control panel.
4. Batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.

E. System Reset

1. Means to reset the system to return the control unit to its normal state after all alarm condition have been remedied shall be provided.

2. Should an alarm condition continue to exist, the system shall return to the alarm state. The zone alarm LED shall remain on.

2.2 FIRE ALARM CONTROL PANEL

- A. The fire alarm control panel shall be capable of monitoring and activating multiple initiation circuits. It shall be of a modular design, addressable, and construction with individual modules utilized to monitor each circuit.

2.3 SYSTEM FIELD DEVICES

A. General

1. Initiating devices shall be connected to the initiating circuit by Class B circuits.

B. Fiber Optic Linear Heat Detection

1. The fiber optic linear heat detection system shall consist of a control unit and sensor cable. Additionally commissioning and configuration software as required.
2. The linear heat detection system shall be able to measure a distributed temperature profile along the entire length of the sensor cable using the RAMAN-effect.
3. The fiber optic detection cable shall detect the specified temperature anywhere along the detector length, regardless of the source of the heat. The controller shall have the ability to be programmed to respond to temperature characteristics such as fixed temperature, rate of rise, or differential from zone average.
4. The fiber optic detection cable shall consist of at least two optical fibers type multimode, gradient index, 50-micron core diameter / 125-micron cladding diameter. The cable shall consist of a non-metallic or stainless steel tube with an outside diameter of 1.2 – 1.8mm (0.05 – 0.07 inches). In the tube are two independent color-coded quartz fibers. Depending upon the model selected, the tube is clad with a layer of stainless steel wire or Aramid yarns.
5. The maximum ambient temperature range of the fiber optic detection cable shall be -40° to 85° C (-40° to 185°F).
6. The maximum programmable fixed temperature range of the fiber optic detection cable shall be 57° to 113° C (135° to 235°F).
7. When the detection cable is required to span distances in excess of the Manufacturer's standard mounting guidelines, it shall be paired with a messenger wire. The messenger wire or aircraft type cable shall consist of a high tensile strength corrosion-resistant steel wire which shall support the fiber optic detector when necessary.
8. The fiber optic linear heat detector's core shall be sheathed in a flame-retardant halogen free jacketing material to a diameter of 4mm (0.16 inches).

9. The fiber optic detection cable shall be available in two distinct types.
 - a. Type PFS-554-FR consists of a stainless-steel tube that contains two independent color coded quartz fibers.
 - b. Type PFS-654-MF is metal free and specifically designed for use in applications where a high amount of electromagnetic disturbance is expected.
10. The fiber optic linear heat detector shall be able to be field spliced with appropriate fusion splicing tools.
11. The fiber optic linear heat detector must be immune to electromagnetic interference.
12. The fiber optic linear heat detection controller shall function on the OTDR principle and have the following characteristics:
 - a. Range 1, 2, 4, 6, 8, 10 km per channel
 - b. Spatial Resolution: 1 – 6m adjustable
 - c. Operating Temperature Range: -10° to 60° C (15° to 120°F).
 - d. Power Supply Source requirement: 12 – 30 VDC
 - e. Power Consumption: 15W Typical
 - f. Number of Measurement Channels: 1, 2 or 4 (up to 10, 8, 6km per channel respectively)
 - g. Relays: 44 output (43 programmable, 1 fault)
 - h. 256 definable partitions per channel
 - i. Multiple alarm criteria in same or multiple partitions
 - j. USB/Ethernet/RS232 internal interface, other protocols available through external devices
 - k. Modbus over TCP/IP

2.4 INSTALLATION – GENERAL

- A. The Contractor shall provide and install all required equipment and accessories necessary for the proper operation of the system.
- B. All work shall be performed in accordance with the best and most modern practices of the trade. The final installation shall present a neat appearance.
- C. The entire system shall be installed in a workmanlike manner, in accordance with the standard instructions and recommendations of the Manufacturer, and in accordance with the approved Manufacturer's wiring diagrams, unless deviations are specifically permitted by the Owner's Designated Representative.
- D. Where new penetrations of floor slabs, fire walls, or fire divisions are made, they shall be fire-stopped in accordance with all local codes.
- E. The entire wiring system for the new and/or modified existing fire detection and alarm system shall be in full accordance with the current edition of NFPA 70, National Electrical Code.
- F. The system shall be installed under the supervision of a contractor qualified and trained by Protectowire.

1. A Protectowire trained/certified contractor's name and qualifications shall be submitted to the Owner's Designated Representative in writing. Once approved, the contractor shall not be changed without at least two week's written notice to the Owner's Designated Representative and approval by the Owners' Designated Representative.
 2. The Protectowire trained/certified contractor shall be on site during the entire installation of the new system. The technical representative is expected to be on site during the entire time of final connections and testing of the control equipment and system.
 3. The supervisory work of the Protectowire trained/certified contractor shall include, but not necessarily be limited to: checking all the system wiring connections; advising technical details of the installation; and the adjustment and testing of all components of the system in order to ensure a complete and satisfactorily operable system.
 4. The Protectowire trained/certified contractor shall monitor all wiring changes and ensure a smooth transition to the system.
 5. The cost of training from Protectowire shall be paid by the Contractor and included in the bid price.
- G. The Protectowire trained/certified contractor shall also be required to instruct designated property and management personnel in the general operation of the system and to provide the designated personnel an overview of the system functions when the system is in normal, supervisory mode, alarm mode, and trouble mode.

2.5 INSTALLATION – SPECIFIC CUSTOM APPLICATION

- A. The Contractor shall follow and comply with the Manufacturer's installation instructions for the installation of all equipment
- B. The Linear Heat Detection Cable shall be located in accordance with the appropriate standards and Manufacturer's guidelines. The Linear Heat Detection Cable shall not be recessed in any way into any mounting surface.
- C. When mounted on ceilings the following shall be observed:
1. The Linear Heat Detection Cable shall be located on the ceiling or side wall not more than 20 inches from the ceiling
 2. Except in the case of solid open joist construction, the Linear Heat Detection Cable shall be mounted on the bottom of the joists. In the case of beam construction where beams are less than 12 inches in depth and less than 8 feet on center, the Linear Heat Detection Cable may be installed at the bottom of the beam.
- D. As a minimum, the Linear Heat Detection Cable shall be formed in accordance with the following:
1. The cable shall be installed by hand; mechanical devices shall not be applied to the cable.

2. All bending and fitting shall be performed with installer's fingers. Pliers or other hand tools shall not be used to form the cable.
 3. The minimum bend radius shall be two and one-half (2 1/2) inches; bends shall be freely formed, consistent with the nature of the cable.
- E. As a minimum, the Linear Heat Detection Cable shall be fastened and supported to maintain tautness in accordance with the following:
1. Only fastening and support devices approved by the Manufacturer shall be used to support or connect the cable.
 2. Only stapling machines or tackers approved by the Manufacturer shall be used to fasten the cable.
 3. Only mounting clips approved by the Manufacturer shall be used to attach the cable.
 4. Fastening and supporting devices, including staples, straps, and mounting clips, shall not be placed at intervals greater than ten (10) feet.
- F. The Linear Heat Detection Cable shall be installed in a manner to protect it from physical damage. In areas where it may be subject to physical damage, the Contractor shall install mechanical protection for the cable. As a minimum, the cable shall be protected in accordance with the following:
1. In areas subject to abrasion and/or pinching, the cable shall be mechanically and electrically insulated, as recommended by the Manufacturer.
 2. When the cable passes through a wall, beam, or joist, the hole shall be large enough to allow the cable to be freely drawn through the opening. The cable shall be protected when passing through masonry walls with conduit, tape, or PVC sleeving.
 3. A bushing shall be installed at the open end of metal conduit through which the cable enters or exits.
 4. In areas where the Linear Heat Detection Cable is subject to abuse, it shall be installed in perforated stainless steel conduit in accordance with the Manufacturer's guidelines.
 5. When the cable is installed lower than seven (7) feet from the floor, or when the area to be protected is less than seven (7) feet in the air and unprotected by a structure, the Contractor shall install physical protection in accordance with the Manufacturer's guidelines.
- G. As a minimum, the Linear Heat Detection Cable shall be connected in accordance with the following:
1. The length of the Linear Heat Detection circuits shall not exceed the limits prescribed by the Manufacturer, unless otherwise expressly stipulated in writing and approved by the Manufacturer.
 2. Detection circuit wire other than Linear Heat Detection Cable provided by the Manufacturer shall not be employed for any part of any linear heat and fire detection

circuit, other than field cables from the Fire Alarm Control Panel to the start or end of the detection circuit.

3. All linear heat and fire detection zones shall be terminated in the control panel or in an EOL enclosure supplied by the Manufacturer.
4. All Linear Heat Detection Cable and fire protection circuits shall be wired in a series loop configuration. Circuits with T taps or Y branches shall not be acceptable.
5. Except where special fittings are used, all connections to terminals shall be made by means of soft copper leads (PFL) furnished by the Manufacturer.
6. All splices made in the Linear Heat Detection Cable shall be made only by utilizing splicing connectors furnished by the Manufacturer.

2.6 SCHEDULING

- A. Prior to beginning work, the Contractor shall provide a schedule to the Owner and the Owner's Designated Representative indicating the installation sequence and project time frame.
 1. The schedule shall indicate the installation sequence, the time frame, and details on how the fire alarm control panel activation and switch-over will occur. This schedule shall ensure that system down-time is kept to a minimum. Projected dates of delivery of the equipment to be supplied, installation completion, demonstration test and final test/acceptance dates shall be included.
 2. The Contractor shall provide weekly updates to the Owner and the Owner's Designated Representative.

2.7 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall assure that no equipment is delivered directly from the Manufacturer to the project site.
- B. All equipment shall be delivered to the Protectowire trained/certified contractor prior to delivery to the project site. The Protectowire trained/certified contractor shall open all containers and inspect all products for conformance and integrity prior to delivery to the project site. The Protectowire trained/certified contractor shall repack acceptable products in their original shipping containers and deliver them to the project site in a timely manner consistent with the schedule of the project.
- C. The Contractor shall arrange for secure storage of the materials at the project site. All materials shall be stored in a manner that will protect them from removal and damage prior to their installation.

2.8 CLEAN-UP

- A. Progressively during the course of installation and following completion of the installation, the Contractor shall remove all trash, debris, and surplus materials occasioned by this project, such that the environment presents a safe, neat, and orderly condition conducts to other activities at all times.
- B. At the completion of work, each day, the Contractor shall assure that the work area is left in an orderly manner so as not to interfere with other activities occurring in the area.

2.9 AS-BUILT DRAWINGS

- A. The Contractor shall deliver a complete set of reproducible, as-built drawings and four (4) copies of the drawings to the Owner or the Owner's Designated Representative upon completion of the installation of the system, and a minimum of one week prior to the demonstration test.
- B. A copy of the as-built drawings shall be submitted to the fire department prior to the fire department's Acceptance Test.
- C. The Contractor shall show the following information on these as-built drawings:
 - 1. The exact locations and installation details of the installed equipment and zone of each device.
 - 2. The exact location of all existing initiating devices and notification appliances.
 - 3. The installed wiring and color coding and wire tag notifications for the exact locations of all installed equipment.
 - 4. Locations of each end-of-line resistor and end-of-line device.
 - 5. Specific point-to-point interconnections between all equipment and internal wiring of the equipment. Typical point-to-point wiring diagrams are not acceptable.
 - 6. Layout of the annunciator panel and designations of each indicator.
 - 7. All modifications to the facilities.

2.10 TRAINING REQUIREMENTS

- A. Prior to final acceptance of the fire alarm system, the Contractor and supplier shall provide operation training to each shift of the Owner's personnel. Each training session shall be conducted during shifts or at another time acceptable to the Owner. Each session shall include an overview of the system and the devices connected to it, emergency procedures (including alarm, trouble and supervisory condition procedures), control panel operation, and safety requirements. Each session shall include a complete demonstration of the system. Dates and

times of each training period shall be coordinated through the Owner, not less than two weeks prior to the training session.

2.11 OPERATING INSTRUCTIONS

- A. The Contractor shall provide Operating and User Instruction Manuals a minimum of one week prior to the demonstration test of the system. Four (4) complete sets of operating and instruction manuals shall be delivered to the Owner upon completion, and one (1) to the fire department prior to final acceptance.
- B. User operating instructions shall be provided, prominently displayed on the cabinet front or on a separate plastic laminated sheet located next to the control unit.

2.12 TESTING INSTRUCTIONS

- A. Prior to final acceptance, the Contractor shall deliver to the Owner complete, simple, comprehensive, step-by-step testing instructions providing recommended and required testing frequency of all equipment, methods for testing each individual piece of equipment, and a complete troubleshooting manual explaining what might be wrong if a certain malfunction occurs and explaining how to test the primary internal parts of each piece of equipment.

2.13 MAINTENANCE INSTRUCTIONS

- A. Prior to final acceptance, the Contractor shall provide four (4) complete sets of maintenance instruction manuals to the Owner.
- B. A 5 year maintenance plan shall be included with annual maintenance inspections defined by the Owner.
- C. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:
 - 1. All aspects of the system operation and maintenance shall be detailed, including a written description of the specific system design (a typical description will not be accepted), system logic diagrams, electrical wiring diagrams of all circuits, drawings illustrating equipment locations, and technical data sheets describing each piece of equipment used in the system.
 - 2. Instructions on replacing any components of the system, including internal parts.
 - 3. Instructions on periodic cleaning and adjustment of equipment with a schedule of these functions.
 - 4. A complete list of all equipment and components with information as to the address and phone number of both the Manufacturer and local supplier of each item.

2.14 MONITORING SERVICE

- A. The Contractor shall coordinate with a local Fire Alarm Monitoring company and arrange 5 years of monitoring service with the Owners approval. Cost of 5 year monitoring service will be included into Contractors bid.

2.15 DEMONSTRATION TEST

- A. The Contractor shall be responsible for coordinating and conducting the demonstration test.
- B. Upon completion of the installation of the fire alarm system, the Contractor shall provide a minimum of one week's notice to the Owner and the Owner's Designated Representative that the fire alarm system has been satisfactorily tested by the Protectowire trained/certified contractor and is ready for the demonstration test.
- C. At the time of notification, the Contractor shall submit "As-Built" drawings and a "Test Plan" which shall describe how the system will be tested.
 - 1. The test plan shall include a step-by-step description of all tests to be performed and shall indicate type and location of test apparatus to be employed. The tests shall demonstrate that the operating and installation requirements of this specification have been met.
 - 2. The demonstration test shall not be conducted until the "Test Plan" is approved.
- D. All tests shall be conducted in the presence of the Owner and the Owner's Designated Representative.
- E. The Contractor shall provide all the necessary personnel and equipment required to conduct the test.
- F. At the demonstration test, the Protectowire trained/certified contractor shall deliver to the Owner's Designated Representative an Inspection and Test Report, which shall be completed in conjunction with the demonstration test and shall indicate the following:
 - 1. Project information, including name, address, and city.
 - 2. The Contractor's name, address, city, and telephone number.
 - 3. The control panel configuration, serial number, extent of battery backup, locations of remote annunciators, a description of remote functions, and type of fire department connection.
 - 4. The total quantity of alarm signal units, pull stations, and each type of detector.
 - 5. The quantity of alarm signal units, pull stations, and each type of detector in each zone. In addition, the connection position of each device shall be indicated, and, further, indicate the test result of each device and any subsequent action taken.

6. Pertinent comments regarding the installation, operation, testing, inspecting, or other aspects of the system.
 7. The Protectowire trained/certified contractor shall print his/her name and affiliation and sign and date the document.
- G. The tests shall demonstrate that the entire control system functions as intended. All circuits and devices shall be tested, including equipment shutdown, alarm signaling devices, and auxiliary functions. In addition, supervision of each circuit shall be tested.
- H. As a minimum, the Contractor shall perform the following:
1. Operate every fire alarm device to ensure proper operation, correct annunciation at each remote annunciator and at the control panel, and proper operation of auxiliary functions. Where applying heat would damage any detector, they may be manually operated.
 2. The initiating circuits and the notification circuits shall be opened in at least two locations per zone to check for the presence of correct supervisory circuitry.
 3. One-half of all tests shall be performed on battery standby power.
- I. Upon satisfactory completion of the demonstration test, the Contractor shall leave the system operating for a minimum of one week prior to the fire department's Acceptance Test.
- J. If unsatisfactory results occur during or after the demonstration test, the Contractor shall be responsible for any and all additional charges incurred by the Owner with respect to corrective action including, but not limited to, test monitoring and engineering services during the time it takes to obtain final acceptance by the Owner.

2.16 FIRE DEPARTMENT ACCEPTANCE TEST

- A. Before the installation shall be considered completed and acceptable by the awarding authority, the fire department acceptance test shall be performed. This test shall be coordinated and performed by the factory trained Contractor's job foreman, in the presence of, the Owner's Designated Representative, and a representative of the fire department.
- B. The system shall be considered ready for the fire department acceptance test only after successful completion of the demonstration test, and a minimum of one week of satisfactory operation of the system after the successful completion of the demonstration test.
- C. In order to assure attendance of the fire department, the fire department must be provided reasonable notification of the test date by the Contractor at least forty-eight (48) hours prior to the final test.
- D. The Contractor shall provide all the necessary personnel and equipment required to conduct the test.

- E. At a minimum, the Contractor shall perform the following:
 - 1. Operate every fire alarm device to ensure proper operation of the system, including correct annunciation at each remote annunciator and at the control panel, and proper operation of auxiliary functions. Where applying heat would destroy any detector, they may be manually operated.
 - 2. The initiating circuits and the notification circuits shall be opened in at least two locations per zone to check for the presence of correct supervisory circuitry.
 - 3. One-half of all tests shall be performed on battery standby power.
- F. Upon satisfactory completion of the tests, the Contractor shall leave the fire alarm system in proper working order and without additional expense to the Owner, shall replace any defective materials or equipment provided by him/her under this Contract.
- G. When the testing has been completed to the satisfaction of the Contractor's job foreman, the representative of the Manufacturer, and the Owner's Designated Representative, a notarized letter co-signed by each attesting to the satisfactory completions of said testing shall be forwarded to the Owner and the fire department.

2.17 SPARE PARTS

- A. The Contractor shall furnish spare parts in quantities as stated below:
 - 1. Provide 1- 1000m spare fiber optic cable.
- B. All spare parts shall be neatly and protectively packed into one or more cartons. The quantity, Manufacturer, and model of each unit in the carton shall be identified on the outside of the carton. In addition, the name, address, and telephone number of the Contractor and of the Manufacturer's local representative, plus the date of delivery, shall be neatly identified on the cover of each carton.

2.18 WARRANTY

- A. The Contractor shall guarantee all new equipment and new wiring free from defects in workmanship and inherent mechanical and electrical defects for a period of one (1) year from date of the final acceptance. During that period, the Contractor shall replace any defective materials or equipment provided by him/her under the contract without additional expense to the Owner.
- B. The Manufacturer shall warranty against Manufacturer's defects all new system equipment for a period of one (1) year from the date of shipment of the system.

- C. The Contractor shall guarantee all new raceways, new wiring, and connections to existing wiring to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.
- D. Upon completion of the installation of the fire alarm and protective systems equipment, the Contractor shall provide to the Owner's Designated Representative a signed written statement, substantially in form as follows:
 - 1. "The undersigned, having been engaged as the Contractor on the Linear Heat Detection System installation on the Montana FWP, Bannack State Park, 4200 Bannack Rd., Dillon MT project, confirms that the fire alarm and protective system equipment was installed in accordance with the wiring diagrams, instructions, directions, and technical specifications provided to us by the Manufacturer and Owner's Designated Representative."

END OF SECTION 262416